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Forthcoming Events.

MAY 19.

The Ceramic Society (Refractory Materials Section):—Spring meeting at Buxton.

MAY 20.

Institution of Production Engineers:—General meeting in London. "Mechanical Costing," Paper by S. C. Downes.

Royal Society of Arts:—Ordinary meeting in London. "William Sturgeon and the Centenary of the Electric-magnet," Paper by Professor John Ambrose Fleming, M.A., D.Sc., F.R.S.

MAY 21.

Institution of Mining and Metallurgy:—General meeting in London.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

Institute of British Foundrymen.

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The New Wembley.

If last year for the foundryman the late Palace of Engineering, now the Palace of Transport and Housing, was regarded as the *raison d'être* for a visit, such an object no longer exists. This Palace this year is but the ghost of its former glory. The 600 exhibits have shrunk to something less than 60, and its very emptiness, to our mind, advertises its certain failure. There are more engineering exhibits of interest outside this Palace than in it. But foundry work being an essential to every industry, it is everywhere in evidence. There seems to us to be more moving machinery in the Palace of Industry than was the case last year, and with it, of course, is evident the application of castings to the various industries represented. A foundry owner, searching for new markets to enter, will find much food for thought. There are many stands utilising conveyors in some form or other, whilst there are numerous automatic machines. The colonial pavilions, too, have a certain amount of machinery showing, such as a refrigerator plant in the Australian section. This is the only important aspect of the British Empire Exhibition of direct—if direct it can be called—interest to the foundryman.

For all practical purposes the heavy engineering and metallurgical industries are non-existent. The mass assembly of a motor-car, whilst of interest to the man in the street, is a familiar process to the majority of foundrymen, even though not directly concerned with the automobile industry.

An aspect of Wembley which we do not like is the "market-place" methods employed by some of the exhibitors. An article of general use being "demonstrated" by a man "blessed with the gift of the gab" is a combination which should be excluded from any serious exhibition.

We hope that no foreign or colonial buyers of large engineering or metallurgical plant are this year visiting London under the impression that Wembley contains a representative exhibit of what British industry is capable of doing. It was representative last year. This is important, as such a misconception may act prejudicially against British trade at a time when it can least afford it. The case we have in mind is where a colonial or foreign foundryman visited the Palace of Engineering last year, saw something of real interest and decides to send a colleague, under the impression that the Palace of Engineering is practically the same. If such a case comes to the notice of any of our readers, we shall be pleased to arrange an itinerary to embrace the manufactures in which any buyer may be interested. We hope that the publicity department of Wembley has taken steps to acquaint any overseas visitors that no section is devoted to engineering.

The exhibition has undoubtedly lost its greatest asset, that of novelty, but it is so big that we have yet to meet a person who has seen everything, and there is no reason why many enjoyable days should not be spent at Wembley, learning more of the potentialities of the British Empire. The exhibition has been thoroughly redecorated, and presents a smarter appearance than last year. Foundrymen visiting Wembley must regard it as a "joy trip" associated with general education, and not as a serious business project.

Institute of British Foundrymen.

LANCASHIRE BRANCH (Junior Section).

The "John Wilkinson" Memorial Medal.

At the Manchester College of Technology on Saturday, May 2, the examination for the "John Wilkinson" Memorial Medal took place. This medal has been presented by Mr. J. Thewlis Johnson, of the firm of Messrs. Richard Johnson & Nephew, Manchester, for competition among the members of the Junior Section of the Lancashire Branch, and aroused much interest, the number of competitors being 85. Every facility was given by the authorities of the College, two large rooms being set aside for the purpose, and a number of members of the Branch attended to assist in carrying out the arrangements. Among them were Messrs. R. Stubbs (the President of the Junior Section), Jowett, Meadowcroft, Primrose, Smith, Sutcliffe and Makemson (Branch secretary). The examination lasted an hour and a half. One object in view being to give equal chances to those engaged in different trades, the examination paper in Part A was divided into five sections—ironfounding, coremaking, non-ferrous metal founding, metallurgy, and patternmaking. Five questions were put in each section. In ironfounding one question was, What will be the weight of a cast-iron plate 6 ft. sq. by 6 in. thick? With this exception three answers to each question were printed on the paper, one being correct, and the candidate was required to indicate by a cross what he considered to be the correct answer. It was necessary to attempt all the questions from any two sections, and two questions from each of the other sections. Part 2 of the examination paper was of a different character. Six questions were set, as to the chief constituents of cast iron, the advantages of oil sands, the different types of furnaces used, and so forth, and the candidate was required to attempt two of these questions, each answer not exceeding 250 words. The papers will be adjudicated upon by a committee composed of members of the Branch.

Two Indian Foundry Appointments.

Mr. D. W. Downing, a member of the London Branch of the Institute of British Foundrymen, has been appointed by the Bihar and Orissa Government, India, superintendent of the Tirhat Technical Institute, Muzafferpur. Mr. Downing went to India in 1918, during the late war, for the purpose of expediting war material for the Mesopotamian and Dardanelles theatres. He served his apprenticeship with the Darlington Forge as an iron and steel moulder. He afterwards became associated with Wm. Beardmore & Company, of Parkhead, Glasgow; Springfield Steel Foundry, Parkhead; Fraser & Chalmers, Erith; and the London Steel Foundry Company, of Brunsdown. Since being in India he has held the following appointments: works manager to the Empire Engineering Works, Cawnpore; works manager to the Madras and Southern Mahratta Railway Works, Arkowhdra; foundry superintendent to the Britannia Engineering Works, Titajhur, and foundry superintendent to the Indian Iron & Steel Company, Hirapur, Asansol. Last year he resigned his position with the last-named firm to visit England, and on returning to India was appointed instructor in engineering, metallurgy, and iron, steel and non-ferrous foundry work. As noted, he has recently been appointed principal.

Mr. H. Lewin, who, it will be remembered, won the second prize in our Foundry Designing Competition in 1921, has just terminated a three-years' contract as Inspector of Castings under the Government of India, and has been appointed general manager of the Eastern Light Castings Company, Limited, of Kulti, India. Mr. Lewin is a member of the Sheffield Branch of the Institute of British Foundrymen.

Eastwood, Swingler & Company, Limited, are being wound up voluntarily, with Mr. W. Campion, of Irongate, Derby, as liquidator.

Institute of Metals.

NORTH-EAST COAST LOCAL SECTION.

The annual general meeting of the above was held at Armstrong College, Newcastle-on-Tyne, on Tuesday, April 28, Prof. H. Louis, M.A., D.Sc. (retiring Chairman), presiding.

On the motion of Prof. Louis, Mr. H. J. Young, F.I.C., was unanimously elected Chairman for the coming session, with Dr. F. Cook as Vice-Chairman. Mr. E. G. Brownlow was re-appointed Hon. Secretary and Treasurer, whilst the new Committee is as follows:—Messrs. Dunford Smith, R. Dowson (Associate member), C. Gresty, S. G. Homfray, A. Logan and C. E. Pearson.

A vote of thanks was enthusiastically accorded to the retiring Chairman and his officers for the valuable services which they had rendered throughout the session.

The Report for the session 1924-1925 was read and adopted. It stated that the present membership of the Local Section is 115, there being 32 Members and 83 Associates, as against 32 Members and 36 Associates for the previous session. Six meetings have been held in Newcastle, the average attendance being 58 as against 16 for the previous session.

An excellent programme has been prepared for next session, including a joint meeting with the Newcastle Branch of the Institute of British Foundrymen.

Thermal Expansion of Aluminium and Aluminium Alloys.

Data on the thermal expansion of four samples of aluminium and 51 samples of important aluminium alloys are given in Scientific Paper No. 497 of the American Bureau of Standards. The preparation, chemical composition, heat treatment, etc., are included. Most of the specimens were examined in a range from room temperature to about 500 deg. C. Typical expansion curves of the various groups of samples are shown and discussed. In some cases the data on expansion were compared with the equilibrium diagrams of binary alloys. After the expansion tests, the changes in length from the original lengths were determined.

A description of the apparatus used in this research and a review of the available information obtained by previous observers on the thermal expansion of aluminum and some of its alloys are given.

The paper closes with a table showing the average coefficients of expansion of the materials investigated, over several temperature ranges. Copies are obtainable from the American Bureau of Standards, Washington, D.C., U.S.A., at 15 cents each.—"Iron Age."

Soil Formation.

At a meeting of the Refractories Association held at the Royal Victoria Hotel, Sheffield, on Friday evening last, the 8th inst., Mr. W. Hugill, M.Met., of the Refractories Department of the Sheffield University, gave an interesting lecture entitled, "Soils and Soil Formation." Mr. Frank Russell, F.G.S., F.E.S., of the General Refractories Company, Limited, a past-president of the Association, was in the chair.

The lecture was illustrated by a number of lantern slides, and Mr. Hugill dealt fully with the effect of the various Geological formations on the soils, such as limestone, sand, clay, chalk, etc., etc. He also described in detail some of the scientific experiments on the subject of soil formation which have been carried out at Rothamstead for many years. An interesting discussion followed, in which Mr. Russell, Mr. F. G. Foster, Mr. F. M. Fisher, Mr. A. L. Greenwell, Mr. W. J. Rees, and others took part.

Royal Visit to a Bell Foundry.

Last Tuesday the King and Queen visited the bell foundry of Messrs. Gillet & Johnston, Union Road, Croydon, to inspect a carillon of 53 bells made for a New York church. The set weighs 100 tons, the bass being 9 tons.

"Peeling" in White-Heart Malleable.*

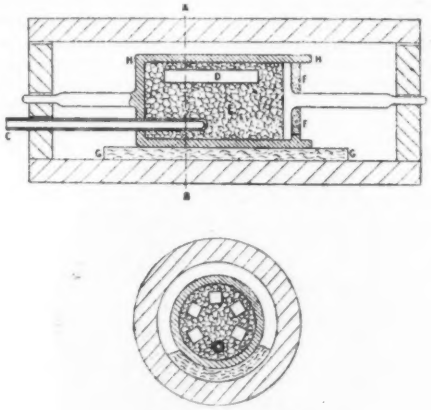
By Douglas H. Ingall, M.Sc. (County Technical College, Wednesbury), and H. Field (Willenhall).

INTRODUCTION.

The phenomenon of "peeling" with which this Paper deals is a defect well known both to malleable ironfounders and machinists, being met with frequently in the manufacture and use of malleable cast iron.

Castings suffering from this defect present a normal outward appearance, but the fracture after breaking reveals an inner core, surrounded by one or more layers of "skin" or "peel," these layers being so loosely attached to the core and to one another that either they become detached in the breaking or can be removed by a few blows with a hammer. The remaining core then presents a smooth surface, and has generally the same contour as the original specimen. Fractures of "peeled" malleable iron are illustrated in Fig. 3, which shows the separated peel in one part and the remaining core at another.

The mechanical properties of the metal are not greatly affected by the presence of this internal defect, except in cases where it may be very pronounced, notably thin plates, where the core may be entirely absent and the metal a series only of



SECTION A—B.

C, couple tube; D, specimen; E, ore; F, fireclay lining; G, asbestos pad; H, experimental pot.

FIG. 1.

"skins." In breaking tensile test bars or in bending tests it is noticed that both skin and core elongate together for a time, after which the skin begins to crack and part from the core. The trouble with "peeled" castings arises when they are machined, as either in planing or screwing the entire skin may come away from the core, or in milder cases the threads peel off as a string. Smaller castings which are not machined are often water-barrelled before plating, and this prolonged process sometimes wears right through the outer skin at one place and the whole then peels off.

One of the authors, engaged in the production of malleable castings, came frequently across such defective castings, and an attempt was made to locate the faulty procedure involved, although no formula was found which satisfied every case. It became apparent that the question was one for systematic research, and the method chosen—as shown in another part of the Paper—has been to reproduce the phenomenon under known conditions.

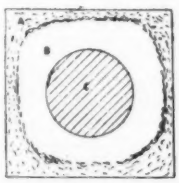
In works practice it has been found that the trouble can be attributed to a large number of causes, and in fact at different times it has been accounted for as due to variation in almost any and every part of the process. References in published work are very scanty, and, so far as the authors are aware, there are none in any of the foundry text-books. In the discussion of a Paper by Hurren[1] various speakers spoke of peeling as due to (*a*) the oven having its temperature raised too quickly; (*b*) high manganese content; (*c*) high sulphur content; (*d*) too high annealing temperature; (*e*) too strong annealing ore.

W. H. Poole[2] describes the phenomenon carefully, and formulates a theory, as also does J. W. Gardom,[3] both of these writers attributing the defect to a rate of carbon elimination at the surface more rapid than that of the diffusion of carbon within the casting.

Description of Sphere of Work, Equipment, Samples, &c.

From the known irregularity of the occurrence of "peeling" in works practice, and in view of the divergent and sometimes conflicting opinions expressed on the phenomenon, it was obvious, at the outset, that the investigations would have to cover a wide field. The possible controlling influences appeared to be capable of classification, under the following main headings: (1) Chemical composition of the cast iron; (2) structure of the cast iron; (3) temperature of annealing; (4) time of annealing; (5) rate of heating to annealing temperature, and (6) nature of the annealing ore.

The experimental work was therefore developed to investigate the above-mentioned influences under known conditions, as mentioned in the introduction, but at the same time every endeavour was made to make the known conditions



A=oxide penetration; B=ferrite; C=pearlite and ferrite.

FIG. 2.

such that they could be directly comparable with works practice.

Annealing Furnace.—Fig. 1 shows a diagrammatic sketch of a section through the annealing furnace, which was a horizontal electric resistance tube furnace, the silica tube being 4¾ in. inside diameter and 18 in. long. The tube was closed at each end with firebrick non-heated plugs 2 in. thick.

Annealing Cans.—These were made of ordinary white cast iron of the kind known in the trade as "can metal." Each can was of cylindrical form, 4 in. inside diameter and 6 in. long. As shown in Fig. 1, a lug was cast on one end of each box and also on the lid to help to support the box in the furnace. A hole was also cast at the end of each box, at a radius to which the specimens were inserted, to take a nickel-chromium tube containing the thermocouple. This tube was wedged into position with asbestos paper, and the sealing of the iron with each experiment was quite sufficient to seal it in. After the lid was placed in position, it was luted up with fireclay.

Specimens. — All the specimens were cast in greensand under works conditions to dimensions 3½ in. by ¾ in. sq. Bars Nos. 1, 2, 4, 5, 6 and 7 were cast from a crucible, each being from a different brand of pig-iron. Nos. 3 and 8 are ordinary cupola melted cast iron for malleable work, containing 25 per cent. of each of two pig-irons and 50 per cent. of foundry scrap. Series A to E, F to H, and L to P, were each made by melting virgin pig-iron and adding iron sulphide in varying amounts to give a steady increase in sulphur. CM is a metal used for annealing cans for malleable work.

The analyses of the specimens used are given in

* A Paper read before the Iron and Steel Institute

[1] Proceedings of the Institute of British Foundrymen, 1921-22, p. 222.

[2] *Ibid.*, 1922-23, p. 125.

[3] FOUNDRY TRADE JOURNAL, April 3 and 10, 1924.

Table I, some figures being omitted in series cast from the same melt.

Annealing Ore.—This was taken from the stock in use at the malleable annealing ovens, and consisted of four parts of used ore and one part of new red hematite ore, the whole being of 70 Kibble mesh.

Temperature Measurements.—These were made by means of a platinum, platinum-rhodium couple inserted into the couple tube. As no continuous recording instruments were available, the temperature records were made from frequent readings. It was found by observation that the

Table I.—*Composition of Irons used.*

Descriptive Mark of specimen.	Silicon.	Sulphur.	Phosphorus.	Manganese.	Total Carbon.	Graphitic Carbon.
1	0.427	0.56	0.035	0.09	2.90	nil
2	0.635	0.35	0.046	0.099	2.95	,,
3	0.496	0.53	0.060	0.075	2.75	,,
4	0.718	0.30	0.035	0.130	3.15	,,
5	0.750	0.178	0.033	0.225	2.88	,,
6	0.875	0.42	0.040	0.020	2.87	,,
7	0.690	0.068	0.070	0.025	3.07	,,
8	0.760	0.345	0.079	0.20	3.30	,,
A	0.605	0.278	0.043	0.24	3.49	,,
B	0.575	0.375	—	0.23	—	,,
C	0.555	0.406	—	0.20	—	,,
D	0.585	0.425	—	0.20	—	,,
E	0.590	0.405	0.043	0.20	3.46	,,
F	0.575	0.110	0.085	0.08	2.96	,,
H	0.605	0.140	0.083	0.12	3.10	,,
K	0.560	0.200	—	—	—	,,
L	0.550	0.046	0.086	0.140	3.48	,,
M	0.520	0.138	—	0.158	—	,,
N	0.520	0.210	—	0.138	—	,,
P	0.520	0.083	—	0.164	—	,,
CM	0.320	0.242	0.098	1.250	3.31	,,

fluctuations (due to variations in the electric supply) did not amount to more than plus or minus 12 deg. C., which was well within works practice.

Rate of Heating.—To conform to works practice, the rate of heating, *unless otherwise specified*, was

Fig. 3.

in each case about thirty hours to reach the required temperature, and about thirty hours to cool off.

Peeling.—For descriptive purposes, the amounts of peeling obtained have been divided into three categories—slight, moderate, and heavy. By "slight" is meant a thin flake with a thickness of the order of a piece of paper. "Moderate" is about half-way between the thickness of "slight" and that of "heavy," the latter being approximately $\frac{1}{16}$th of an inch. These sizes are merely intended to convey a rough idea as, naturally, many variations of thicknesses were obtained.

Testing.—To test for "peeling," the specimens were clamped firmly in a vice for 1 in. of their length, and then gradually bent over with blows from a hammer until fracture occurred. The fractures were then examined for the separation of peel from core.

Description of Experiments.

Experiment A.—To Investigate Chemical Composition.

Specimens of 1, 2, 3, 4, 5, 6 and 7, giving a wide range of composition, were packed in a box and annealed for four days (96 hours) at a temperature of 950 deg. C.

The following were the results when tested for peeling: A1, none; A2, heavy; A3, slight; A4, slight; A5, slight; A6, heavy, and A7, none.

All the samples were fully annealed, without any signs of hardness. From the analyses it was seen that peeling was obtained with metal which exhibited no particular feature with regard to any one of its constituents. The specimen (A2) which had peeled most had quite an average analysis. It was therefore decided to take sulphur prints of the specimens (longitudinal sections) and to examine them microscopically; at the same time, in view of the possible effect of "original structure," it was decided to investigate the microstructure of specimens in the "as cast" condition.

Microstructures of Specimens 1, 2, 3, 4, 5, 6 and 7 in the Cast Condition.—All specimens showed the normal structure of white iron without any particular feature, as shown in Fig. 4, which is characteristic of all the samples.

Longitudinal Sulphur Prints of Specimens A1, A2, A3, A4, A5, A6 and A7.—These prints showed that the peel, where it occurred, was comparatively free from sulphur; but sulphur segregation was found at the boundary between peel and core in patches in specimens A2, A3, A5 and A7, and completely in specimens A4 and A6.

Microstructures of Specimens A1, A2, A3, A4, A5, A6 and A7.—It was found that, broadly speak-

Fig. 4.—× 50. Cast Structure of Specimen.

ing, all specimens exhibited one general type of structure. As this type of structure was also found in all subsequent specimens which were microscopically investigated, and as it revealed the nature of the "peel," it was thought that a somewhat detailed description of it would not be out of place.

A diagrammatic sketch of the structure is given in Fig. 2, which represents a cross-section of a specimen. It is seen that the structure resolves itself into three main zones which, taken in order from the outside of the specimen to the centre, are composed as follows:—Zone 1.—Highly oxidised metal containing free globules of oxide; Zone 2.—Ferrite becoming more and more oxidised towards the border of Zone 1; and Zone 3.—Pearlite and ferrite. The three zones are clearly seen in Fig. 5, taken from specimen A2.

Zone 1.—This is the zone which forms the "peel" in a specimen. The extent and amount of peel is determined by the degree of penetration of this zone. At the boundary of the zone with the ferrite (Zone 2) it was generally found that there was an accumulation of inclusion which was more or less continuous, and the boundary formed the cleavage plane along which the "peel" (Zone 1) separated from the "core" (Zones 2 and 3). Sometimes it was found that Zone 1 contained two or more of these accumulation boundaries, in which case the specimen would exhibit a number of "peels" corresponding with the number of boundaries. The cross-sectional specimen in Fig. 3 shows one such

case. Fracture taking place along two such boundaries is shown in Fig. 6, which is taken from a longitudinal micro-specimen (Specimen G4). Freedom from peeling was found to be consistent with either absence of Zone 1 or its presence to a very limited and irregular extent.

Zone 2.—This zone calls for very little comment. Its oxidised condition towards the boundary of Zone 1 is shown by the staining of the etching reagent in Fig. 5. As would be expected, the grain-size of the ferrite was larger the higher the temperature of annealing.

Zone 3.—The extent of the whole zone and the relative proportion of pearlite in it varied, according to the decarburisation. Generally, as might be inferred, the amount of carbon varied from a minimum at the border of Zone 2 to a maximum at the centre of the specimen. In the cases of incomplete annealing free cementite was found in the central portions.

The relative widths and extents of the three zones were found to vary considerably, according to annealing conditions.

Investigation of the Influence of Temperature of Annealing.

Experiment B.—The samples were annealed for four days (96 hours) at 910 deg. C., specimens 1, 2, 3, 4, 5, 6 and 7 being used. The results with regard to peeling were as follows:—B1, none; B2, none; B3, none; B4, none; B5, slight; B6, slight, and B7, none. The lower temperature obviously did not promote the production of peel, but, on the other hand, the specimens were not thoroughly annealed. Specimens B1 and B3 had centres which were appreciably hard when cut through with a hack-saw.

The microstructures revealed the general type of structure in which Zone 1 was practically absent or irregular, and in Zone 3 there were areas containing more or less free cementite.

Experiment C.—Specimens 1, 2, 3, 4, 5, 6 and 7 were annealed for four days (96 hours) at 1,010 deg. C. The following were the peeling results:—C1, none; C2, slight; C3, none; C4, slight; C5, slight; C6, slight, and C7, slight.

The temperature of this experiment is probably above the maximum aimed at in good works practice, where 1,000 deg. C. is generally looked upon as too high. The results indicate that a high temperature tends to suppress rather than accelerate the production of peel.

All the specimens were quite soft, and the microstructures revealed the general structure, with usually a rather indefinite Zone 1, a fairly wide Zone 2, and a relatively small Zone 3, with low average carbon content, containing in some cases small amounts of graphitic carbon.

Investigations of the Influence of Time of Annealing.

As most peeling had been obtained at 950 deg. C., it was determined to prolong the time of annealing at that temperature.

Experiment D.—Specimens 1, 2, 3, 4, 5, 6 and 7 were annealed for six days (144 hours) at 950 deg. C. The following were the results obtained in regard to peeling:—D1, very heavy; D2, very heavy; D3, very heavy; D4, heavy; D5, heavy; D6, moderate, and D7, none.

The results show at once that, under suitable conditions, the growth of peel progresses with time.

Experiment E.—As the results, especially in D1, D2, and D3, were so much more pronounced than anything obtained previously, it was thought desirable to repeat the conditions. This was done in Experiment E which, with small variations, entirely confirmed the results of Experiment D.

The microstructures were of the general type, giving on an average a comparatively large Zone 1 and a small Zone 3.

TABLE II.—*Silicon and Sulphur content of the zones.*

Specimen.	Silicon.			Sulphur.		
	Outside.	Second position.	Centre.	Outside.	Second position.	Centre.
E1	0.378	0.360	0.377	0.218	0.48	0.520
E2	0.575	0.638	0.600	0.161	0.392	0.60
E3	0.550	0.518	0.540	0.084	0.535	0.79
E4	0.745	0.745	0.770	0.127	0.351	0.64
D5	0.74	0.74	0.755	0.139	0.198	0.172
D6	0.865	0.865	0.820	0.298	0.378	0.426
E6	0.90	0.795	0.80	0.128	0.530	0.70
E7	0.750	0.750	0.71	0.066	0.061	0.061

The authors were yet without evidence as to the influence, or influences, which start the peeling phenomenon. As, in the last two experiments, the extent of the peel reached in some cases to nearly half-way between the outside and centre of the specimens, it was resolved to make analyses with regard to silicon and sulphur on sections of some of the specimens, obtained by milling off successively one-third of the whole specimen all round. The results obtained are shown in Table II. These figures confirm the results of the sulphur prints to the extent of revealing a minimum sulphur content in the peel. Similar analyses on reduced sections of the bars in the hard state showed that the silicon and sulphur in the original metal are equally distributed within macroscopic limits, and without segregation.

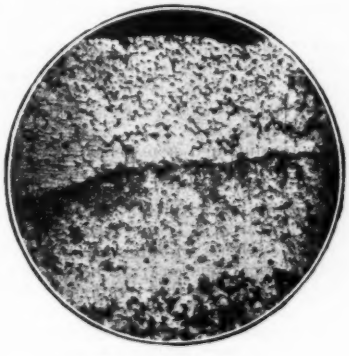


FIG. 5.—× 50.

FIG. 6.—× 50.

Under Works Conditions.

Experiment F.—One of the experimental cans charged with Specimens 1, 2, 3, 4, 5, 6 and 7 was annealed on the top of a pile of cans in a works heat for six days. From the appearance of the specimens the conditions had been closely akin to Experiment C, and the results obtained were very similar.

Sulphur Content of the Metal.

Experiments G and H.—The variations of sulphur distribution as revealed in Table II pointed to the possible influence of sulphur content with regard to peeling. It was therefore determined to investigate specifically the effect of sulphur.

Experiment G.—Specimens A, B, C, D, F, H, K, 8, and CM were annealed for five days (120 hours) at 950 deg. C. The results obtained in regard to peeling were as follows:—GA, slight; GB, slight; GC, slight; GD, slight; GF, none; GH, none; GK, none; G8, slight, and CM, none.

Unfortunately the furnace broke down twice during the running of this experiment, and at one period it accidentally reached a temperature of 1,000 deg. C. for a short time, so that a further test was made. This was the only experiment in

which the high manganese bar CM was included, and in view of the earlier reference, it may be noted that this metal did not peel.

Experiment H.—Specimens A, B, C, D, L, M, N and P were annealed for six days (144 hours) at 950 deg. C. The following were the results in regard to peeling:—HA, slight; HB, slight; HC, moderate HD, none; HL, none; HM, none; HN, moderate, and HP, none.

From a consideration of these results together with former ones, it would appear that both high and low sulphur contents are deterrents towards peeling which may most easily be produced within a range of sulphur content from approximately 0.2 per cent. to 0.4 per cent. The results would also indicate that the higher the silicon content, the greater is the tendency for the production of peel.

Investigation of Rate of Heating.

Experiment J.—For this experiment an abnormal rate of heating was employed to give an extreme result. A temperature of 950 deg. C. was reached in seven hours and maintained for six days (144 hours). Specimens 1, 2, 3, 5, 6, B, D and N were used. The following were the results in regard to peeling:—J1, very slight; J2, very heavy; J3, very heavy; J5, moderate; J6, very heavy, JB, heavy; JD, heavy, and JN, very slight.

It was obvious that rapid heating was an important factor towards the production of peel.

Phenomenon of Peeling and Annealing Effect.

Experiment K.—Specimens 1, 2, 3, 6 and N were subjected to rapid heating in seven hours to 950 deg. C. and maintained at that temperature for two days (48 hours). The following were the results in regard to peeling:—K1, very slight; K2, moderate; K3, moderate; K6, moderate, and KN, very slight.

The results showed that the phenomenon of peeling, when present, commences with the annealing effect. The microstructures were consistent with the general type of structure, according to the conditions, and showed free cementite in Zone 3.

Works Conditions.

Experiments L, M and N.—To verify the experimental results obtained it was decided to carry out a test under ordinary works conditions. An oven running an ordinary works heat was arranged as follows:—

Experiment M.—A thin works can on the top of a tier in centre of the oven, without the corresponding cans each side of it on the neighbouring tiers, so as to expose it freely to the flame.

Experiment N.—A new can in a corresponding position in the oven, but with cans each side giving quite normal conditions.

Experiment L.—Experimental can on the top of can M. Very exposed condition. Specimens in each case 1, 2, 3, 4, 5, 6 and 7.

The oven was fired more rapidly than usual, so that can N reached its normal temperature of probably 950 to 975 deg. C. at a slightly quicker rate. Can M would also be heated at a somewhat faster rate. By intermittent temperature determinations with Watkin's patent heat-recorders, which indicated the temperature within a range of 15 deg. C., the temperature was found to vary between 970 deg. C. and 1,000 deg. C. Can L would be heated most rapidly, and probably had a temperature somewhat over 1,000 deg. C. The heat lasted for six days (144 hours). The results are given in Table III.

TABLE III.—*Amount of peeling.*

Specimen.	Experiment L.	Experiment M.	Experiment N.
1	Heavy	Heavy	Heavy
2	Slight	Slight	,,
3	Heavy	Heavy	,,
4	Very slight	Slight	Very slight
5	,,	Very slight	,,
6	,,	,,	Moderate
7	,,	,,	Very slight

Experiments L, M and N confirm the conclusion that increased rate of heating promotes the development of peel, but that a high annealing temperature retards its growth. To confirm this deduction under drastic conditions the following experiment (P) was carried out:—Specimens 1, 2, 3, 4, 5, 6, 7 and N were heated to 1,050 deg. C. in six hours; cooled to 1,020 deg. C. and so maintained for two days (48 hours).

The following were the results in regard to peeling:—P1, very slight; P2, slight; P3, slight; P4, very slight; P5, very slight; P6, moderate; P7, none, and PN, none.

The results confirm the previous deductions. As all the above experiments were conducted with ore of normal composition, it was thought to be unnecessary to carry out experiments with regard to variations in the composition of the ore.

SUMMARY OF RESULTS.

The authors desire clearly to point out that the following conclusions are put forward in a broad and general way. At the same time, they feel that the work which has been outlined has laid a foundation with regard to the influences underlying the production of "peeling in white-heat malleable," so that detailed conditions may be developed by subsequent research.

In the light of the above statement, the influences effecting the production of peel may be summarised as follows:—

(1) *Chemical Composition.*—Metal containing sulphur between approximately 0.20 and 0.40 per cent. will be liable to peeling, and the higher the silicon content the greater will be the liability.

(2) Temperatures in the neighbourhood of 950 deg. C. are most conducive to peeling. Higher and lower temperatures, though they do not necessarily prevent the formation of peel, retard its growth. With lower temperatures there is, of course, the risk of the material not being completely malleabilised, and with higher temperatures the possibility of burnt metal resulting.

(3) The faster the rate of heating to the annealing temperature, the greater by far is the liability to produce peeling.

(4) "Peel" has been found to consist of a layer or layers of ferrite containing free oxide globules as inclusions. When this layer is once formed it will continue to grow with time, according to temperature conditions (*vide* 2).

(5) The work outlined above has not given any definite proof of the mechanism causing the development of peeling. With the evidence obtained the following view is tentatively put forward.

The formation of peel is the result of oxidation of the metal. There would appear to be an approximate critical temperature between 900 and 940 deg. C. above which this oxidation effect may commence. As soon as oxidation begins, the growth of the oxide layer would appear to depend on the result of a race between rate of oxidation and rate of carbon supply by diffusion from the interior. It is for this reason that rapid heating promotes rapid peel growth, as the cementite has not time to dissolve and diffuse at a rate necessary to counteract the penetrating oxidation. The retarding effect of high temperatures will be seen to be due to the more rapid solution and diffusion of the cementite.

The authors have no explanation to offer with regard to the rôle played by the sulphur content of the material.

The authors desire to record their thanks to Messrs. John Harper & Company, Limited, Willenhall, for the foundry and analytical facilities placed at their disposal; to the Staffordshire Education Committee for the opportunity to carry out the microscopical and experimental part of the work; and to Mr. J. W. Jones, M.Sc., for active interest.

Patent Specifications.

Particulars of complete specifications accepted, furnished by Mr. Eric Potter, Patent Agent, of Lonsdale Chambers, 27, Chancery Lane, London, W.C.2. Printed copies of the specifications in the following list are now on sale.

212,534. DUGINS, W. F. Machine for cutting metal strips. March 10, 1923.

232,411. RHEINISCHE METALLWAARENUND MASCHINENFABRIK and KNAEBEL, B. Cutting off drawing tubes, etc. April 24, 1924.

230,058. LUTHY, J. O. Treatment of old plates of secondary batteries. February 28, 1924.

The Microscope as a Foundry Adjunct.

At the conclusion of the annual general meeting of the Lancashire Branch of the Institute of British Foundrymen, Mr. J. G. S. Primrose, metallurgist to Messrs. Richard Johnson & Nephew, Limited, Manchester, gave an illustrated talk on the microscope as a foundry adjunct. In the course of his remarks Mr. Primrose said:—

When anyone was asked to express an opinion in regard to the nature or suitability of a foundry material, usually the first thing to be done was to make a close scrutiny or inspection of it visually and then examine it by touch. This gave a useful basis impression, but there were many points which escaped such a casual observation and could only be revealed by a properly conducted test, physical, chemical or, often more usefully, microscopical. At one time the microscope was regarded as a scientific toy which was of no real practical value to the foundryman; by far the greatest stress had been laid on the opinions of specialists who studied the inner structure of metals and alloys, often in a state or of a composition, which in no way directly interested the practical worker. By long experience of the appearances connected with the requisite properties in his materials, the foundryman came to know pretty accurately what suited his purpose when the conditions were normal, and as they changed he could make adjustments. That easy-going way had now been speeded up. The best raw materials were no longer available,

Fig. 1.—Cast Iron Perfectly Welded to a Steel Tube × 100 dias.

and the modern worker did well to impress into his service every available source of information which would enable him to select rapidly what was likely to be best for the immediate purpose in view without adopting the costly method of trial and error, which usually succeeded through fortuitous circumstances which were not easy to reproduce when required.

It was a mistake to consider the microscope was chiefly of value in the foundry for the study of metals. With very little practice it could be used in the examination of sands, coke and other materials. Anyone could derive benefit from it without going very deeply into the principles of its construction or optical details, but it was essential to understand the meaning of what the microscope image showed. This depended upon the lighting effect used to illuminate the object examined, and the simplest way was to utilise transmitted light which silhouetted opaque objects or particles and passed through transparent ones with slight loss, sufficient to make them visible. This means might be used either alone or in conjunction with the oblique lighting, which was permissible with low-power observation, as it set up very marked shadow effects with rough surfaces. It was specially applicable to metal fractures where uneven surfaces were exposed. The most critical illumination was vertical, which passed into the tube of the microscope and was suitably reflected on to the smoothed surface of what was to be inspected, at fairly high magnification and where only slight variation in surface level was permissible. This difference of level might be brought about purposely by the means used for preparing the surface, either in the polishing operation itself, or by a subsequent roughening through etching in a suitable medium, which often at the same time coloured the various constituents of a metal differently, and thus enabled them to be readily distinguished.

Moulding Sands.

From a series of photo-micrographs of foundry sands which had been microscopically tested to ascertain their suitability for various purposes, it was demonstrated how the ordinary physical tests were usefully supplemented. First a sand taken from the River Clyde was shown to explain why this gave a fine skin to the facings of light castings. The grain size was shown to be very small and uniform, and the very small quantity of bond or binding material which consisted of small particles of clay was sometimes adhering to the sand grains and sometimes separate. A different shape of grain was observed in sea sand, which was shown to be constituted of rounded particles of large size, with no clay or bond in it, whatever was needed for binding purposes had to be added to it. In the next specimen, a Belfast red sand, the grain size was small and very uniform with small, evenly distributed particles of bond. For certain purposes this was better than the Clyde River sand. The fourth photo-micro-

Fig. 2.—Open Structure of Old Metal in Test Bar × 500 dias.

graph showed a silica sand, the grains of which were very sharp and angular with no clay bond.

Crystallisation.

The next series of slides illustrated the growth of crystals in iron and the agglomeration of crystal units into dendrites. The author exhibited a specimen of the "fir-tree" crystal growth of iron measuring 19½ in. long. The skeleton structure had evidently been built up with its primary axis at right-angles to the cooling face. This had sent out offshoots at right-angles to the first axis and to one another. Tertiary axes had then formed, and between the branches of these and the primary crystals small amounts of more fusible material had solidified. When the growth of one crystal was interfered with by the others adjoining, it became no longer a true-shaped or idiomorphic crystal but irregularly shaped or allotrimorphic.

The general appearance of the main constituents of iron was fully illustrated. Mr. Primrose pointed out how the distribution and shape of the inclusions and graphite were influenced by the rate of cooling for certain compositions useful for different ranges of section. This microscopical means of examination was demonstrated as being of the greatest practical use in the investigation of the causes of irregular occurrences in cast metals, and also for finding the most probable cause for defects arising out of wrong composition, melting or heat-treatment. From this the necessary remedy was as a rule easily apparent.

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Burning-on.

The microscope showed the conditions necessary for the proper carrying out of the very difficult job of uniting cast iron to wrought iron or steel so as to get it thoroughly homogeneous. A case actually shown was that of a mild-steel lubricating tube run in a very thin casting. A complete inter-crystallisation or fusion of the two masses of metal was required to make a sound join, and the way in which the cleaned surface of the mild-steel tube had been carburised from the molten cast iron was shown in micro-section (Fig. 1). The junction line of the two metals showed free cementite passing into pearlite and then ferrite with pearlite of the normal steel structure, whilst the iron was free from separated graphite or blow-

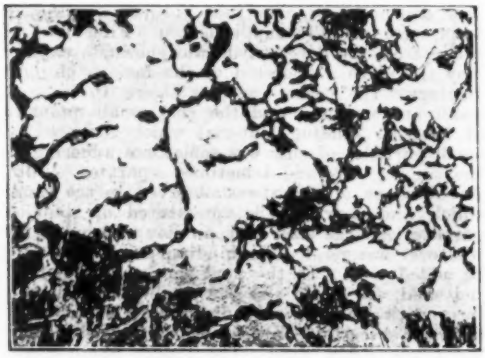

FIG. 3.—CLOSE STRUCTURE IN "BURNT ON" PART OF TEST BAR × 500 DIAS.

holes at the adjoining surface, thus making a continuous metal joint all round the tube.

The next operation described was that of burning-on to iron a portion of the similar metal, as in the case of a fractured part; or the actual example taken of a test bar which had been broken in two pieces purposely and then burned together again. The transverse test broke clear of the burn, and the tensile piece turned from it also broke at 12 tons per sq. in. quite away from the join in the old metal, which was obviously the weaker. The photo-micrograph of the original iron showed the cooling had been such that large graphite flakes had formed the ground-mass, which was largely sorbitic-pearlitic but with

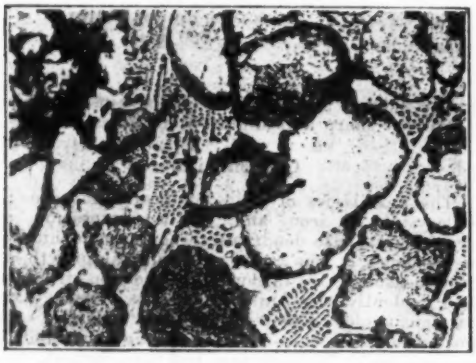

FIG. 4.—COARSE STRUCTURE OF FRACTURED CAST IRON WATER PIPE.

segregated phosphide inclusions in it: whereas in the new metal of practically identical composition, the graphite was very much smaller and the phosphide in the strong mesh-work formation. A comparison of the photo-micrographs showed why the new portion was therefore stronger than the old (Figs. 2 and 3).

A series of photo-micrographs were next shown by slides illustrating the effect of annealing too-hard castings where the machining had been rendered difficult by excessive pearlite or even free cementite, but after slow cooling in the furnace used to bring up to a full red heat the amount of carbide had been so materially reduced as to render cooling perfectly easy.

The harmful effect upon the strength of castings by over-annealing them or by too frequently repeated heatings with ordinary composition not intended to withstand such treatment, was illustrated by a further set of slides from which the conclusion was drawn that when it was required to stand up to heat or high temperatures, the graphite flakes must be reduced to the smallest possible size and with as uniform a distribution as could be attained with the rate of cooling needed for the composition selected.

Defective and Sound Pipes.

The vexed question of rate of cooling was illustrated by samples of cast-iron pipe which had accidentally been chilled both by damp moulds

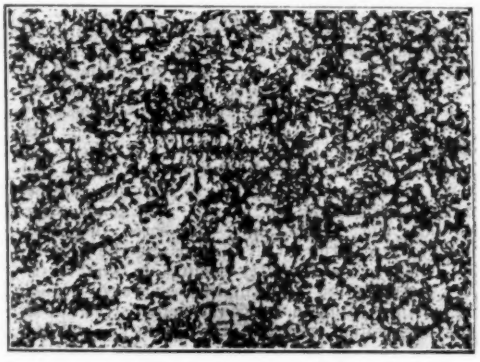

FIG. 5.—FINE GRAIN STRUCTURE OF SPUN CAST IRON PIPE AFTER ANNEALING × 200 DIAS.

and insufficiently dried cores, in which case extreme brittleness accompanied unsoundness due to cavities partly due to the excessive shrinkage accompanying the too rapid cooling. Equally harmful was the too slow cooling of soft iron in cast pipes whereby excessive weakening was caused by the harmful arrangement of the large graphite flakes as well as the excessive segregation of the phosphide. Fig. 4 was the photo-micrograph of a large cast-iron water-pipe which burst, causing great damage. In contrast to this was shown a set of illustrations indicating the completely homogeneous structure with exceedingly minute graphite separations found in "spun" iron pipes

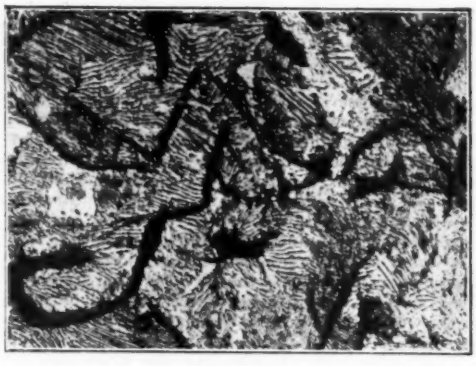

FIG. 6.—STRUCTURE OF COMPLETELY PEARLITIC CAST IRON WITH ONLY GRAPHITE.

both in the "as-cast" and after the softening "annealing" treatment (Fig. 5). Comparison was also shown of the effect of mass upon the graphite separation, taking as an example a perfectly satisfactory ½-in. sq. test bar which was meant to represent a thick cylinder, the bottom of which fell out under the first hydraulic test. Practical examples of refining the grain size of cast iron by using small amounts of aluminium were shown.

Pearlitic Cast Iron.

After dealing extensively with the formation and structure of phosphide globules, the topical question of pearlitic cast iron was discussed, and

comparison made between the naturally pearlitic irons such as cold blast, and the artificially produced mixtures using some proportion of steel in the cupola charge. Whilst most irons contained pearlite, chief interest centred round that new variety which was almost perfectly pearlitic and would have been a white-iron casting if the cooling rate had not been adjusted, either by preheating the mould to the requisite temperature to suit the metal thickness and composition, or by using sufficiently hot metal cast into the cold mould to ensure that the rate of cooling through the critical temperature at which pearlite was formed should be sufficiently low. Usually a composition low in silicon and phosphorus was selected along with moderately high manganese, and the most satisfactory results were secured when the cooling rate also left the graphite separated in the "curly" form instead of the long straight or forked variety. Examples of too slow cooling whereby free silicon-ferrite areas with too large phosphide segregations occurred were shown, and conversely too rapidly cooling where free cementite was left and the best structure was not attained. Reference was made in passing to the increased facility found in machining cast iron with the fully laminated pearlite structure as shown in photo-micrograph (Fig. 6), and further its great soundness when cast, there being an almost complete absence of gas cavities or shrinkage holes as it feeds itself during cooling. Further, the great resistance to heat and abrasion was pointed out, and generally the greatly improved all-round qualities which were rightly attributed to this class of cast iron.

DISCUSSION.

Mr. Sutcliffe asked whether a ½-in. test bar could give a fair indication of the strength of the thick section of a large casting. Spun-iron pipes had been mentioned. Could Mr. Primrose give any information as to their liability to corrosion in comparison with ordinary cast-iron pipes? What percentage of steel would Mr. Primrose recommend for mixing with iron? Was it beneficial to add it to good iron such as cold blast or hematite?

Corrosion of Cast-Iron Pipe.

Mr. Primrose said it was his opinion that a ½-in. test bar did not fairly represent a thick casting. But many people had only a testing machine that would take a ½-in. bar. When they cast a big job they had to take a small section test bar cooled at a rapid rate. Thus castings passed the inspector and then failed under a practical test for the reason that the testing machine was not suitable for the size of casting concerned.

The corrosion of spun pipes was largely dependent on local circumstances. It was accelerated by electrical leakage, which often occurred in streets where tram lines were laid. Perhaps that was an exceptional case. But suppose in a country road no more than the ordinary corrosion took place. It might be that the ordinary cast-iron pipe would have a chilled skin, and being thicker it might have an advantage compared with the spun pipe. But in the latter there was less difference between adjacent parts than was the case with sand cast-iron pipes, and to his mind the homogeneous structure of the spun pipe was likely to withstand corrosion to a greater degree.

Object of Adding Steel.

The percentage of steel which should be added to an iron mixture depended on what they were trying to get. It depended upon the amount of silicon which the iron contained and the amount they desired to reduce it to. With cold-blast iron, which presumably was already of the composition required, no steel need be put in. In what was called "burnt" pig-iron it might run to 4 or 5 per cent., which would take from 50 to 60 per cent. of steel to bring it down to a good iron; otherwise it would be too open in grain. The addition of steel to hematite would not necessarily improve it. It would reduce the silicon and perhaps make the metal too hard. Hematite was often put in for softening purposes, and putting in steel nullified that softening and made it hard.

Mr. H. Sherburn said in many small foundries the most important problem in this matter—one which Mr. Primrose had not solved—was how a foundryman who was busily occupied with the cares of management could avail himself of the advantages which a study of the microscope offered. A knowledge of chemistry gave him information which stood him in good stead, but his lot would be a difficult one indeed if he had to become skilful in operating the microscope and understand all about the constituents with the somewhat remarkable names a few of which Mr. Primrose had mentioned. It was unfortunate that many of the microscopic constituents of iron alloys bore names which had no relation to their composition. Perhaps there was some simple form of instrument which one could easily carry about and examine castings with and so forth, but would such a cursory examination carry them very far? There was no doubt whatever as to the advantage of micro-analysis in foundry practice, but it was a science which few foundrymen could thoroughly assimilate in addition to their other duties.

Practical Application of the Microscope.

Mr. Primrose said this was a point he had been hammering at for many years. A firm who could afford it ought to have a trained man who could put it to a foreman, "That is the structure you have obtained. This is the structure you require." Then they could collaborate in getting it. If that was not possible for financial reasons, the foundryman could at least get a boy to polish up a selected specimen, or, if need be, he could take the suspected part of some casting, set the microscope over it, and examine the general structure, the graphitic distribution, and so forth. He could etch it by dropping a little acid on it, and the phosphide mesh work would reveal itself. Even at a very low magnification the pearlite areas would be recognisable, although they would not be resolved. The reason why this constituent was called "pearlite" was this. Professor Sorby, of Sheffield, many years ago examined nearly all these structures, and found that this constituent presented an appearance resembling the colourings of laminated mother-of-pearl. It was better to give it that name than the name of an individual, which had been done with many of the other constituents.

Mr. Hogg asked if a small part of an irregular casting was examined under a microscope, how far would that justify a judgment being formed of the structure in the other parts.

Making all Sections the Same Structure.

Mr. Primrose replied that obviously the structure would be different in different parts. The whole idea in the production of pearlitic iron was to make an adjustment for a given composition which they must presume would run all through the casting—to adjust the rate of cooling of different sections so as to get a uniform structure. The Germans had succeeded in doing that, but it was the sort of thing not often attempted in this country. Naturally, if no precautions were taken, there would be heavy sections and thin sections, and variations of structure. In order to get an average of the different parts, then, different sections must be tested, and not one part only. But it was a useful thing to bring before the draughtsman in order to show him that when the iron gave large variations in structure as well as in physical properties, his design was at fault. Personally his experience was that he had often persuaded a draughtsman to alter a design by showing him that he defeated his own object by making a casting thick, when by coring out and spreading the metal and making it thinner, a uniform section could be obtained and associated with a stronger casting.

Burning On.

Mr. S. G. Smith said he agreed with Mr. Primrose that when a burn had been made properly it rarely broke. The reason for that had been explained by the slides shown. But could Mr. Primrose also explain what often happened in making burns on American iron. At the first trial the piece which was being burned on was full

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of honeycomb which did not occur in the other piece. When they came to make the second burn, after that first attempt, it was usually successful.

As a rule aluminium densified the iron, but it was a very peculiar thing that with very soft material it closed the iron. It was often used in making very fine castings of almost lace-like patterns.

He was greatly interested in the subject of phosphorus pellets. The theory was put forward that these pellets, containing perhaps 6 to 8 per cent. of phosphorus, were squeezed out. It was very rarely they contained the ordinary amount of phosphorus found in the body of the iron. At different times he had had such pellets analysed, and his opinion was that it was possible during the solidification of the iron they had been squeezed out of different parts of the casting, but there were other reasons why pellets should be formed. In a specimen he had found one pellet had been formed inside another with a clear space around it. They were very small, about the size of a pin-head.

Could Mr. Primrose tell them why cold-blast iron was so much superior to hot-blast iron. Very often when there was little difference in the composition there was a tremendous difference in the physical properties.

He quite appreciated the importance of carbon absorption. He had had faulty blades in turbine castings analysed, and found they absorbed carbon by being in contact with the molten iron when poured. He had pointed this out to engineers who were loth to believe it, but it was a fact.

Pearlite and Pearlitic Cast Iron.

The most interesting of the slides were those which showed the pearlitic cast iron. He was pleased that Mr. Primrose had given to Dr. Sorby the credit for the discovery of this pearlitic structure. So much had been said about pearlitic cast iron in Germany, that some people might get the idea that it originated in that country. All cast iron, he believed, had a pearlitic structure more or less, and he did not quite know what was meant by "perfect pearlitic structure." Was there a difference between pearlite and pearlitic structure? He understood pearlitic iron contained 0.89 of carbon. What had become of the other 2 per cent. or more of carbon?

Burning on British to American Cast Iron.

MR. PRIMROSE said in burning all depended on getting a perfect inter-crystallising between the added metal and the old metal. Why that could be done was often due to the phosphorus. The heat from the burned iron would soften and perhaps melt out the lower melting-point eutectic so that the new metal was keyed into the old structure. Usually the rate of cooling was slower in the new metal than in the smaller mass which was being burned on to. It was not always a big, solid body, but a leg or a foot, or a slight projection; therefore the bigger mass of metal would cool more slowly and give a more uniformly and lower-stressed material. The added metal, being practically unstrained, was really stronger than the original piece.

The honeycomb development described by Mr. Smith as occurring in burning on American iron was probably due to a difference in the composition of the metal. American iron was often highly graphitic, and the heat of burning on was sufficient to convert the graphite into gas, which was trapped in the added metal, forming the honeycomb. When the second burning took place that graphite had been already burned away, and therefore could not produce another evolution of gas; so there was no honeycomb in the second attempt. This explanation was only a surmise, as he had not examined such a specimen microscopically.

A very good feature of testing with the microscope was that it did not involve the destruction of the test piece, which was the case with other methods. A bit of a casting, or several bits, could be polished and examined, and when the examination was over they had still got the casting left.

Phosphide Eutectic Pellets.

He had found quite a number of phosphorus pellets in pig-iron as well as in cast iron. Inside the pellet the percentage of phosphorus might be normal, but on the skin it would be about 8 or 10 per cent. On a former occasion he had been incautious enough to suggest that possibly the phosphorus pellets were formed by a skin forming round a portion of the metal whilst still in the ladle, but he had found that many pellets were due to actual chilled spots, and there would be carbide, not phosphide, structures formed, which made for very great hardness.

The chief reason why cold-blast iron was better was that the lower the smelting temperature and the greater the cooling rate, the more likely they were to get the maximum amount of pearlite in the structure. Very few of the ordinary straight irons would develop that strong pearlite structure and reproduce it after re-melting, as cold-blast iron did. The next best thing that would do it was semi-steel. Mixing with steel reproduced that pearlitic structure which was present in the cold-blast iron and could be repeated on re-melting. It depended on several things—the composition, the rate of melting, the rate of cooling.

Pearlitic Cast Iron Explained.

In pearlitic iron the idea was to get the *maximum* amount of pearlite in the ground mass of the metal. The percentage 0.89 of carbon was the eutectoid or pearlite point for steel, but when phosphorus, silicon and other elements were present that eutectoid or pearlite point was lower; the combined carbon might be as low as 0.75, and it would still be a *maximum* pearlite structure. The ferrite present in pearlite was not structurally free; it was mechanically associated with cementite in the pearlite. If there was any structurally free ferrite it was no longer a maximum pearlite structure.

Vote of Thanks.

In proposing a vote of thanks to Mr. Primrose, MR. HAIGH said he was pleased the lecturer had not said that it was necessary for foundrymen to become microscopists, as he was afraid foundry foremen had not time to become expert with the microscope; they ought, however, to learn the meaning of what the microscope revealed. They could all do that. He was glad Mr. Primrose had pointed out that it could be used in examining other things besides metals; they heard so much about the micro-structure of metals that they forgot there were other materials such as sand, coke, blacking, etc., used in the foundry which ought to be analysed and put under the microscope. He could give instances where considerable savings had resulted from the adoption of such a course. One case was where a local sand was used instead of sand from a distance, because it was found by testing, first in the laboratory and then by actual use, to be as serviceable as the sand it replaced, owing to the grain being right and the constituents just as good. The lecturer had shown the necessity of collaboration between the laboratory and the actual users of the various materials, and the desirability of the foundrymen being able to understand the meaning of microscopic slides and photographs when placed before them. It must be remembered that the microscope dealt with very small sections, say ¼ in. sq. area, and it would be very difficult to convince foundrymen that small sections of this nature should be used for the purpose of rejecting a casting. They were not, of course, used for this purpose, but were useful as illustrating whether the structure of the material was as required.

The vote of thanks was seconded by MR. MILES and passed unanimously.

MR. S. PRIESTLAND, late foundry foreman at the works of John Brown & Company, Limited, Scunthorpe Steel Works, who has retired after 37 years' service, owing to ill-health, has been the recipient of a handsome presentation from the officials and men.

The Iron and Steel Institute.

Annual Meeting in London.

The Annual General Meeting of the Iron and Steel Institute was opened at the Institution of Civil Engineers, Great George Street, Westminster, last Thursday. At the outset the retiring President (Sir W. H. Ellis) took the chair.

THE SECRETARY (Mr. G. C. Lloyd) submitted the Report of the Council for the year 1924, of which the following is an abstract.

Report of Council.

The Council of the Institute, in their report on the proceedings and work of the Institute during the year 1924, state that during the year 99 new members and 16 associates were elected, and nine associates were transferred to membership, the total membership of the Institute on the register at December 31, 1924, being therefore as follows:—Patron, 1; honorary members, 11; life members, 80; ordinary members, 1,964; associates, 37; total, 2,093. Seventy members and one associate resigned their membership during the year, and the names of 43 members and 5 associates were removed from the register owing to the non-payment of their subscriptions. The deaths of 26 members were reported to the Council during the year.

Finance.—The statement of accounts shows that the income for the year was £8,068, exclusive of the Carnegie Scholarship Fund and of the interest received from investments constituting the Special Purposes Fund, and the expenditure for the year was £7,568, as compared with £8,095 and £8,012 respectively in 1923.

Andrew Carnegie Research Scholarships.—Grants were made during the year by the Council, on the recommendation of the Carnegie Scholarship Committee, to the following candidates:—

C. H. Adamson (Sheffield) and G. S. Bell (Lincoln), £100 jointly, to carry out an investigation on transverse test-bars of cast iron of various mixtures, and to determine the relation between the strength, properties, and chemical composition.

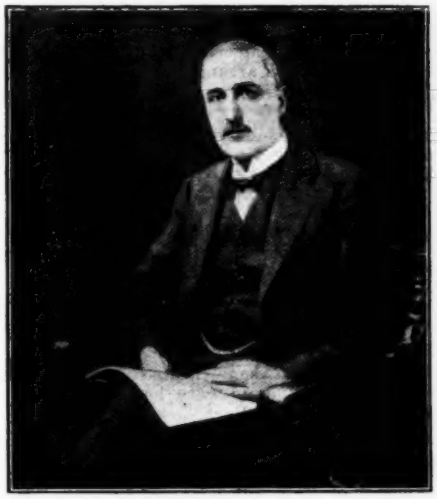
L. Aitchison (Birmingham), £100, to carry out a research on the critical quenching velocity of steel and the influence of composition upon it.

C. E. Pearson (Newcastle-on-Tyne), £75, to investigate the growth of commercial grey cast iron, with special reference to composition, grain-size, and casting thickness.

E. R. Taylor (Birmingham), £75, to ascertain the relationship between sulphur and other ingredients of white iron in connection with the production of white-heart malleable castings.

It was also recommended that a further grant of £50 be made to O. W. Ellis (Toronto University) (who had received a grant of £100 in 1922), to enable him to install certain apparatus for continuing his research work already reported on.

Appointment of Representatives.—The President continues to represent the Institute on the General Committee of the Royal Society for administering Government Grants for Scientific Investigations. Sir Robert Hadfield, Bart., and Mr. F. W. Harbord, C.B.E., represent the Institute on the Board of the National Physical Laboratory, and Sir Hugh Bell, Bart., represents the Institute on the Board of Governors of the Imperial College of Science and Technology. The Institute representatives on the British Engineering Standards Association are Dr. A. Cooper, Mr. M. Mannaberg, and Mr. B. Talbot. On the Sub-Committee of that Association, for the Standardisation of Galvanised Sheets, Mr. C. Dorman continues to serve; while Mr. H. J. Yates and Dr. W. H. Hatfield are the representatives on the Sub-Committee for Cast Iron, working under the direction of the Sectional Aircraft Committee; Mr. H. B. Toy represents the Institute on the Sectional Committee on Cast Iron; Mr. J. H. S. Dickenson is the representative on the Technical Committee of Motor Industries; and Mr. F. W. Harbord, C.B.E., on the Sectional Committee for Chemical Engineering. Mr. F. Clements is the Institute representative on the Institution of Civil Engineers' Panel D on Gas-Producer Trials. Professor T. Turner acts as the Delegate of the Institute to the British Cast Iron Research Association. Mr. Harbord is the representative on the British Refractories Research Association, and also on the Alloys of Iron Research Committee. The Institute is represented by Dr. A. Cooper, Mr. M. Mannaberg, Mr. G. Hatton, C.B.E., and Mr. B. Talbot on the Committee on the Improvement and Development of Basic Slag, formed by the Ministry of Agriculture and Fisheries. Professor T. Turner represents the Institute on the Grey and Malleable Iron Research Committee of the Department of Scientific and Industrial Research; on the Technical Committee of Lloyd's Register of British and Foreign Shipping the Institute is represented by Lord Invernairn and Mr. W. Simons. Sir Robert Hadfield, Bart., represents the Institute on the British Association Fuel Economy Committee, on the Court of Sheffield University, and on the Home Committee for the University of Hongkong; while on the Court of the University of Liverpool the Institute is represented by Sir W. Peter Rylands. Mr. F. W. Harbord acts as representative on the



SIR FREDERICK MILLS, BT., D.L., M.INST.C.E., M.I. MECH.E.

President of the Iron and Steel Institute.

Advisory Board of the Royal School of Mines, and, with Sir Robert Hadfield, Bart., represents the Institute on the Federal Council for Pure and Applied Chemistry.

Changes on the Council.—The statutory year just concluded is the first during which the newly altered By-law 10, limiting to one year the period during which a President should hold office, has been in operation, and the Council in accordance therewith unanimously nominated Sir Frederick Mills, Bart. (Vice-President), to succeed Sir William Ellis as President. Mr. W. H. Hewlett, Mr. C. J. Bagley, and Mr. E. Steer (Vice-Presidents) have been elected Honorary Vice-Presidents, the vacancies caused in the list of Vice-Presidents having been filled by the election of Mr. W. R. Lysaght, C.B.E., Mr. F. W. Harbord, C.B.E., and Mr. B. Talbot as Vice-Presidents respectively. Professor H. Le Chatelier, F.R.S., has also been elected as Honorary Vice-President, and Mr. F. W. Gilbertson has resigned his seat on the Council. The vacancies on the Council which have thus occurred have been filled by the election of Professor C. H. Desch, F.R.S.; Mr. V. B. Stewart, C.B.E.; Professor T. Turner, F.I.C.; Mr. W. Simons and Mr. A. Dreux.

The names of the following Vice-Presidents and Members of Council were announced at the Autumn Meeting as being due to retire (in accord-

ance with By-law 10) at the Annual Meeting in 1925:—*Vice-Presidents.*—Mr. A. Lamberton, Sir W. Charles Wright, K.B.E., Mr. M. Mannaberg. *Members of Council.*—Mr. C. Markham, Mr. G. Hatton, Mr. B. Talbot, Mr. H. Brearley, Professor H. Louis. Mr. Talbot having in the meantime been elected a Vice-President, the vacancy thus arising has been filled by the election of Mr. A. Dreux, who is now due to retire in rotation in place of Mr. Talbot. No other members having been nominated up to one month previous to the meeting, in response to the announcement made at the Autumn Meeting, the retiring members, subject to the change specified, are now presented for re-election.

THE RETIRING PRESIDENT offered a very cordial welcome to Dr. Benedicks, one of the Honorary Vice-Presidents of the Institute. Dr. Benedicks had recently returned from a visit to the United States, where he had given a series of lectures, and it was a great pleasure to the members to see him present at the meeting.

Induction of New President.

THE RETIRING PRESIDENT, in introducing Sir Frederick Mills as the new President, said that Sir Frederick was well known, not only to all the members, but in the industrial life of the country, and it was unnecessary for him to express to Sir Frederick their full confidence in his personality, his ability and his knowledge in taking up the Presidency of the Institute. Sir W. Ellis went on to remark that some Papers of considerable importance, most useful from the scientific side of the Institute, were about to be read, while a very important Autumn Meeting would be held in Birmingham, for which arrangements were being made by Dr. Hutton, Professor Turner and Mr. Jacks. A series of very interesting visits would be made in and about Birmingham, and assurances had been received that quite a good number of members would attend the meeting. He desired to congratulate Sir Frederick Mills on being elected to the high office of President. Sir Frederick would take the chair with a feeling of confidence on the part of not only all his colleagues on the Council, but, he believed, of the members in general. On behalf of all the members he wished Sir Frederick every good luck and success in the Presidential Chair, which he now asked him to occupy.

The Chair was then vacated by Sir William Ellis, and taken, amid very hearty applause, by Sir Frederick Mills, Bart.

THE PRESIDENT said he desired in the first place to thank his colleagues on the Council for their confidence in conferring upon him the honour of Presidency of their world-famous Institute; and in view of the measure of applause with which he had been greeted on taking the Chair, he thanked the members for their apparent confidence in him also.

Vote of Thanks to Sir W. Ellis.

SIR ROBERT HADFIELD, BART., said he was sure the members would not desire to proceed further with the programme of the meeting without first offering their heartiest thanks to Sir William Ellis for his able conduct in the Chair during his term of office. Two or three years ago Sir William expressed to him some doubt with regard to the advisability of his continuing his work for the Institute, but he (the speaker) thought he could take a little credit to himself for having persuaded Sir William to continue as a member of Council and eventually to take the Chair which he had filled so admirably. On the previous evening the Council Dinner to the retiring President was held, and he wished the members in general could have heard the terms, not only of respect, but of affection, with which Sir William was regarded. Sir William's father, Mr. J. D. Ellis, was one of the oldest members of the Institute, and it was largely through the help of Mr. J. D. Ellis that the Institute paid that memorable visit to Sheffield, which was still considered as one of its records. As one of the senior members of the Council it was a great pleasure to him to propose the vote of thanks, which he was sure would be most heartily accorded. He further desired to offer on behalf of the members their very best wishes and regards to Sir William on the fact that he was about to enter upon another very important post. Sir William would step out of one Presidential Chair into another, and if he only filled the Presidential Chair of the Institution of Civil Engineers with the success that had attended his efforts in the Chair of the Iron and Steel Institute he would do a great work for the Institution of Civil Engineers. He was sure it would be the wish of the members that they should couple with the vote of thanks to Sir William for his past services their best wishes for his success in the new office which he was about to undertake.

The resolution was then put and carried by acclamation.

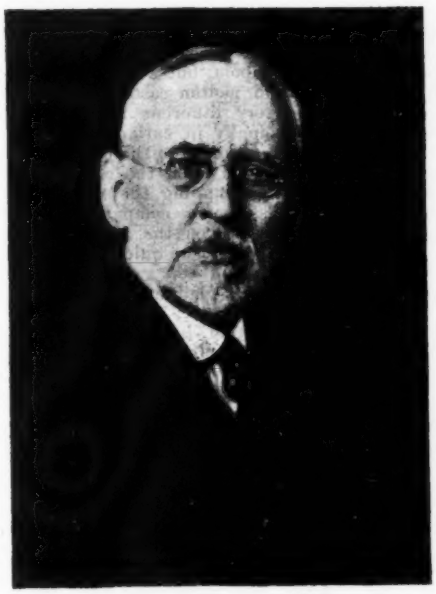
SIR WILLIAM ELLIS, G.B.E., D.Eng. (Past-President), cordially thanked the members for the hearty manner in which they had received Sir Robert Hadfield's remarks. At the Council Dinner held on the previous evening it was quite correct, as Sir Robert had stated, that a very warm feeling was expressed towards himself, which he appreciated very fully. He hoped his colleagues on the Council appreciated how deeply he felt their kindness. Sir Robert had alluded to his hesitation to take the Presidency of the Institute. That feeling was very largely owing to the fact that he knew the Presidency of the Institution of Civil Engineers was likely to be offered to him, and he therefore had doubts as to whether he ought to undertake both tasks. He hoped and believed, however, that the Presidency of the Institution of Civil Engineers being held by an individual who had just given up the Presidency of the Institute might not be without credit to the Institute, and show that there was that close association between metallurgy and engineering that ought to exist in this country and that ought to be increased as far as possible, because progress would result from close co-operation between the leading metallurgists and leading engineers of the country. He thought that was a very good excuse for anyone following from the Presidency of one Institute to another. He thanked most warmly his colleagues on the Council and the members for all their kindness and the support they had given him while he had occupied the Chair.

Presentation of the Bessemer Gold Medal.

The PRESIDENT said that his first duty as President was to make the award of the Bessemer Gold Medal, and it was his very great pleasure to offer that medal in the name of the Institute to Professor Turner, in recognition of his distinguished services in the advancement of the science of metallurgy of iron and steel. For many years Professor Turners name had been familiar to the members as Professor of Metallurgy at Birmingham University. Among those assembled there that day to do Professor Turner honour, there were doubtless many who owed to him their instruction in metallurgical science which had enabled them in their after-life to take prominent positions in the scientific or industrial world, while there were others there who, perhaps not having had the privilege of studying under his immediate guidance, had nevertheless benefited greatly by the results of his investigations in the field of metallurgy. He had the greatest pleasure in handing to Professor Turner the Bessemer Medal, which was a token of the highest honour it was in the capacity of the Institute to confer, and he did so with congratulations, and with the hearty good wishes of all Professor Turner's colleagues and friends there assembled.

PROFESSOR THOMAS TURNER, in acknowledging the presentation, said it was an honour which not only he appreciated, but also his family, many students in various parts of the world, and his University. He was particularly pleased to be associated with the name of Sir Henry Bessemer. All people were more or less hero worshippers, and Bessemer was certainly one of his heroes. It was a long time since he (Professor Turner) attended his first meeting of the Iron and Steel Institute, namely, in 1885. He was a visitor on that occasion and was surprised to find that the members were engaged in discussing some work of his own on the influence of silicon on cast iron. His old friend Dr. Stead was reading the Paper, and, with all the assurance of youth, he (Professor Turner) joined in the dis-

cussion and ventured to express views which were not in accord with those of Sir Lothian Bell, that eminent metallurgist, who was then in his prime. Shortly afterwards he was elected a member of the Institute. Another great man was connected with the Institute at that time, namely, Dr. Percy, who was the then President. He consulted Dr. Percy during the months that followed as to whether or not he might venture to read a Paper before the Institute, being then very young. Dr. Percy's reply was that the greater part of the work of the world was done by young men. So encouraged, he drafted a Paper and submitted it to Dr. Percy before it was read to the Institute. When the Paper was read, Sir Henry Bessemer was present and listened with interest to it. He afterwards came up to him and, in the very kindest way, shook hands with him and expressed his congratulations. He need not say that such an action on the part of so eminent a man was highly appreciated by the young researcher. The members would understand that, apart altogether from the honour which the Institute had been good enough to confer upon him, it was a great pleasure to him to have his name associated in that way with the great English metallurgist and inventor, Sir Henry Bessemer.



PROFESSOR THOMAS TURNER,
M.Sc., A.R.S.M., F.I.C.,
Bessemer Gold Medallist.

PROFESSOR THOMAS TURNER was born at Birmingham, and was educated at a private school in Edgbaston and at the Royal School of Mines, London. He was appointed Demonstrator of Chemistry at Mason College, 1883, and commenced researches on the influence of silicon on iron and steel. Among notable papers he has contributed is one to the Chemical Society in 1885, and one on "The Constituents of Cast Iron" to the Iron and Steel Institute in 1886, which, by indicating the effect of each of the elements usually present, laid the foundation of scientific ironfounding. Turning to wrought iron, he has published papers on the "Theory of Puddling," and the effect of reheating and rolling finished iron. He has also devised a sclerometer for testing the hardness of metals and contributed papers on various aspects of the study of hardness. As Professor of Metallurgy in the University of Birmingham since 1902, he has been responsible for the design and equipment of the Metallurgical Section, and is head of a Department distinguished for its metallurgical research, and prolific in publications dealing with many branches of ferrous and non-ferrous metallurgy. Professor Turner is President of the Institute of Metals; Past President of the Staffordshire Iron and Steel Institute, and of the Birmingham Metallurgical Society; Member of Council of the Iron and Steel Institute, the British Cast Iron Research Association and the British Non-Ferrous Metals Research Association; Governor of the Imperial Mineral Resources Bureau; Honorary Member of the Association des Ingenieurs Sortis de l'Ecole Liège, the South African Chemical Mining and Metallurgical Society, the American Foundrymen's Association and the Institute of British Foundrymen; Fellow or Member of various other scientific and technical societies. He was for 8 years Director of Technical Instruction for Staffordshire, and a member of the Worcestershire Education Committee since its foundation. Has been honoured by the establishment of a trust for the award of Thomas Turner gold and bronze medals, and prizes for metallurgy in the University of Birmingham.

THE SWEDISH DIRECT PROCESS.

Having concluded his address proper, which dealt with matters connected with the proportion of the value of finished steel attributable to labour, the President went on to say: Since the address I have just delivered was sent to be printed I have paid a very interesting visit to the Hagfos Works of the Uddeholms Aktiebolag in Sweden, where I saw mild steel made in an electric-arc furnace direct from iron ore. The ore so far used is concentrate, containing 65-70 per cent. of iron, which is mixed with 22 per cent. of fine coal and 10 per cent. lime. Some 2,500 kw.-hrs. per ton are required for the whole process of reduction and refining. The resulting steel was quite fluid and of good quality. The process is admittedly in its experimental stage, and the questions of speed and of economy remain to be demonstrated; but the Company has dismantled one of its modern electric melting furnaces and has decided to install in its place a new unit to test these questions. I was impressed by what I saw, and if the figures of cost, both capital and manufacturing, given to me are confirmed by results, you have here a revolution in steel-making which must have far-reaching effects. I wish to use words of caution; fifty years ago Sir William Siemens made steel in an arc furnace; he also made steel from iron ore direct in a reverberatory furnace. Has Mr. Flodin at long last justified Dr. Siemens' expectations? I wonder! A revolution indeed! Can we picture a steel-making centre where the low-temperature carbonisation of coal will provide gas for gas-electric engines, smokeless fuel for manufacturing and household purposes, and electricity for making steel direct, without the intervention of blast furnaces and pig-iron—and no smoke? We must have—indeed, I have been promised—a Paper by the inventor for our Autumn Meeting. In the meantime I have a certain amount of information which is at the disposal of anyone interested in the subject, which I have thought, in view of the possibilities, of sufficient importance to bring immediately to your notice.

LORD INVERNAIRN said the members had just listened to a most sound, practical and interesting address from the President which he was sure they all greatly valued and appreciated. He therefore had much pleasure in proposing that a hearty vote of thanks be accorded to the President.

The resolution was put and carried by acclamation. THE PRESIDENT briefly acknowledged the compliment.

Catalogues Received.

Electrical Engineering.—The Brush Electrical Engineering Company, Limited, Falcon Works, Loughborough, have sent us a copy of their latest brochure, which contains a full illustrated description of their Loughborough plant. It consists of 24 art pages, and describes successively the new turbine shop, the alternator winding shop, the heavy machine shop, rolling-stock shops, the transformer shop, and the dynamo and motor shops. In addition to a general description of the works, an account is given of the Brush-Ljungström turbo-generator, followed by a number of instances where loss has been turned to profit through their installation in a number of well-known electricity-generating works.

Moulding Boxes. — The Sterling Foundry Specialities, Limited, of Bedford, have sent us a 16-page catalogue printed on art paper. It is admirably produced. The object has been to describe and illustrate the various types of boxes they have made for special duty purposes. Some are modified as to shape, whilst others have special pin arrangements. All, however, are different from the twenty standard styles which would normally meet the majority of requirements.

A Calendar.—It is a little unusual to receive a calendar in May, but the one just published by Messrs. William Beardmore & Company, Limited, of Glasgow, would be welcome any time, as the detachable illustrations are exceedingly pleasing. The calendar covers the period from this month to April, 1926, there being two months per page. The six etchings are by Frank H. Mason, and are slightly reminiscent of the Whistler impressionist school. Recipients of this calendar can consider themselves very fortunate.

Discussion on Mr. Stobie's Paper, "The Electric Furnace in the Iron Foundry."*

The discussion was opened by the CHAIRMAN, who said that they were indebted to Mr. Stobie for a very instructive paper. Apparently the lecturer had considered the possibilities of the electric furnace from the technical point of view, and it seemed that it was still a matter of trial and error. Also the cost of the electric furnace seemed to be a considerable item compared with that of the cupola. With reference to the use of burnt metal, the Chairman said they had found that it was possible to neutralise burnt metal by means of the addition of high-silicon pig-iron. They had found that cast iron borings were very difficult to deal with in the cupola, and that the only way to get over the difficulty was to send them down to the furnace in tins. With regard to slag and its contact with the electrodes, he would be interested to know if the slag was a conductor or if it was a resistor?

Carbon Absorption.

MR. C. W. H. HOLMES said he was interested in the production of high-carbon metal in the furnace with the carbon hearth, and in his statement that it was more costly to produce high total-carbon synthetic pig-iron in the electric furnace than it was to produce a low total-carbon pig-iron, because, after the content had reached 3 per cent., the absorption of carbon became slower. So far as he (the speaker) was concerned, however, the point of producing high total-carbon iron did not arise because, if he wanted to buy an electric furnace product, it would be because he wanted something special which could not be obtained in the ordinary way. If they could get a good product, low in phosphorus and sulphur, and varying reasonably in silicon and manganese, and with a total carbon of 3 per cent., he thought it would be a very good foundry proposition, and would command a considerably higher price than ordinary hematite. He felt sure that they had all, at one time or another, been up against the difficulty of wanting to reduce the phosphorus and, at the same time, increase the strength of the metal. If, as was usual under ordinary circumstances, lower phosphorus was obtained by using hematite pig-iron, the result was generally an increase in total carbon, and what was gained by the reduction of phosphorus was probably lost by this increase in total carbon. This was where the electric furnace would be useful, provided it was a commercial proposition, because low phosphorus and at the same time low carbon metal could be produced.

Change of Equilibrium on Casting.

Mr. Stobie had referred to oxygen being in equilibrium in molten cast iron and steel, but, because the oxygen was in equilibrium in the molten metal, it did not necessarily follow that it would be in equilibrium when the metal had been removed from the furnace. To his mind equilibrium of oxygen in cast iron and steel depended very largely upon temperature. Those interested in the technical side of the matter should bear this in mind, and it would help them to deal with a question which perhaps had been rather puzzling to them.

He would like to ask the lecturer's opinion as to whether the reduction of oxygen in a synthetic cast iron caused an increase in the tensile strength of the metal. He personally had found it difficult to arrive at a definite decision, as it seemed to have been proved conclusively that it did raise the tensile, whilst equal proof was put forward by other people that it did not. He thought, however, that if he had to give an opinion one way or another, he would say that a reduction of oxygen did not necessarily raise the tensile. He was of the opinion that Johnson had developed his oxygen theory of cast iron very logically and reasonably.

* This Paper appeared in our last issue.

Cost of Electr'c Furnaces.

MR. C. GRESTY said that the lecturer had given some idea as to the running cost of an electric furnace, but no mention had been made of the capital cost, and he would be interested to know the approximate cost of a furnace to refine, say, 25 tons of cupola-melted iron per week. With reference to the electrodes, he would like to know whether they were easily replaced if accidentally broken during the run, and what delay such a replacement would cause.

The author had dealt with the remelting of cast iron borings, and he (Mr. Gresty) presumed that they were simply charged into the furnace without briquetting or any other treatment.

He understood that the semi-steel referred to by Mr. Stobie was not the ordinary so-called semi-steel made in the cupola, but was really a mixture of molten steel and molten cast iron, a material which would be very different from the cupola-made metal, principally in carbon-content.

The lecturer had referred to the ease with which samples could be taken from the electric furnace and analysed before tapping the metal. In the case of steel, this was a comparatively simple matter, but with cast iron the difficulty arose as to how the sample was to be quickly prepared for analysis, on account of its great hardness if chilled. He would be glad of some information upon this point.

He was not altogether in agreement with Mr. Stobie that it was impossible to control the cupola to the same extent as the electric furnace, because if the cupola was worked with the same amount of supervision as the electric furnace, he did not think there would be very much to choose between them from the control point of view. As a general rule, of course, the cupola did not receive anything like the same amount of attention as the electric furnace.

Chilling of Cast Iron.

MR. W. J. PAULIN drew attention to the fact that Mr. Stobie had mentioned that he could take samples from the electric furnace and determine from them the depth of chilling. but he (Mr. Paulin) would point out that there were other effects which could not be found by making such a test. When the mould was poured the hot iron came in contact with the chill, with the result that the first chilling took place and shrinkage occurred during the pastic condition. There was also another effect, namely, the chill became hot, and the chilling effect was therefore diminished.

He thought that the question of the difficulty of adding certain metalloids to the cupola was one about which a good deal of information was desirable.

The author had referred to the fact that in certain cases blow holes could be dispensed with by using aluminium. They themselves had used a certain amount of aluminium in castings where they were anxious to get clean surfaces for machining, but he doubted whether the majority of people considered this necessary.

He was interested in the fact that Mr. Stobie used steel turnings, and would like to ask him if he had found that rust caused them to be more difficult to use.

THE AUTHOR'S REPLY.

In reply to the Chairman, Mr. Stobie stated that slag was what was electrically called a "secondary conductor"; in other words, it was a conductor under certain circumstances. Unless slag contained much iron oxide, or other metallic oxide other than silicon and aluminium oxides, it was when cold, a non-conductor, but at a red-heat it became a conductor.

Limited Application.

He agreed with Mr. Holmes that it was only economical to use an electric furnace, if special castings were required, *i.e.*, castings which would

bring more than the ordinary price. He had been told by one or two good authorities that if one could put on the market regularly an iron with a tensile strength above the ordinary, and be able to guarantee that all castings made therefrom were exactly the same, both in physical and chemical properties, it ought to command several pounds per ton more than did ordinary metal. The only question to be considered was how much extra would have to be charged in order to cover the higher cost of production.

He thought that Mr. Holmes had not quite understood his remarks about equilibrium of oxygen. His point had been that the equilibrium of the oxygen in the molten iron gave a quiet bath, but, of course, the moment the latter started to cool down a certain amount of oxygen came out. His idea of using burnt metal had not been to get rid of metalloids, but he thought it would probably do this, although not to a very great extent.

He was interested in Mr. Holmes' remarks about electrically-made steel. It often happened in other processes of steel-manufacture that an iron which was perfect, so far as ordinary analysis revealed, was found to be brittle when tested. When considering this fact, however, one must consider whether it was right to say that the analysis was a good one. It would probably be better to say that the chemical analysis, *so far as the metal had been analysed*, was good. The ordinary analysis was insufficient for judging the physical properties of a metal, and it was necessary to consider those further factors which vitally affected the metal, namely, gases.

In reply to Mr. Holmes' query as to whether a reduction of oxygen caused an increase in the tensile strength of a metal, he said he had not tested for such a variation in cast iron, but would certainly expect it.

No doubt, as Mr. Holmes had said, the question of economy figured largely in the use of the electric furnace in the ironfoundry, and it was the same in the case of a steel foundry. In a foundry which had to produce just ordinary castings, it was useless having any other than the most economical furnace, but for special work it was usually well worth the extra cost if one could be sure that the castings would be perfect, and it was certainly more economical than to spend money on machining castings which might not give the required results when finished.

Cost of Small Furnace.

In reply to Mr. Gresty's question about the capital cost of a furnace, large enough to produce 25 tons of refined iron per week, the lecturer stated that he could not give the exact figure off-hand, and without some further information, such as what quantity of metal would be required at a time, etc.; but, roughly speaking, he thought that the capital cost of, say, a ½-ton furnace, including foundations, etc., would be £2,000 to £3,000.

Now and again an electrode did get broken, but, of course, much depended upon the man working the furnace and also upon the type of scrap used. Turnings were about the best raw material, but these were not always obtainable and, consequently, such things as rail-ends sometimes had to be used. If one of these rail ends was thrown violently against an electrode the latter would certainly break, and the furnace would have to be stopped while it was being repaired, which operation would take from 5-10 minutes to perform, but, if the electrode was broken while the furnace was being charged, it would not stop the men in their work.

The cast-iron borings were charged without briquetting, and the correct method of melting this material was to throw one or two cwts. into the furnace first and allow it to become molten, the temperature being raised before the remainder of the borings was added.

Semi-Cast Iron.

He was interested in what Mr. Gresty had said about semi-steel, because he had heard for the first time a definition of what it really was, and he quite agreed with his remarks about true semi-steel being a mixture of molten steel and cast iron. Personally he would prefer it to be called semi-cast iron!

He also agreed that in the ordinary way the sampling of white iron gave much trouble, but his works used to drill most of theirs at a red heat with a high speed drill, and had not experienced much difficulty. Another method was to pour a sample of the molten metal on to a slab of iron, getting it as thin as possible, and crushing it; but this was a much slower process. The method of drilling at a red heat was the same as that used for sampling the normally unmachinable manganese steel.

Mr. Gresty had expressed doubts as to whether the electric furnace was more controllable than the cupola, if the latter was in the hands of equally skilled men. As Mr. Gresty had had more experience with the cupola, he might see possibilities for it which he (the lecturer) did not. He personally did not feel that it was always possible to tell the physical properties of cast iron made in the cupola, whereas in the case of steel made in the electric furnace by competent men, one could rely upon the results.

MR. GRESTY (interposing) said he was referring to the production of cast iron in both furnaces, and not steel in one furnace against cast iron in the other.

MR. STOBIE replied that with cast iron he thought his case was stronger, as the manufacture of cast iron in an electric furnace was very simple compared with the manufacture of steel therein. In the electric furnace steel changed rapidly, whereas cast iron was very quiet and did what one wanted it to do, but not so when made in the cupola.

Technique of Adding Aluminium.

The use of aluminium, as Mr. Paulin had remarked, was not an uncommon thing. He understood that Mr. Paulin referred to the addition of aluminium to the metal in the ladle, but the danger of adding aluminium to the ladle was to increase the alumina content and, consequently, lower the tensile strength of the metal. If aluminium was added to the metal in the electric furnace, it could be kept there for a sufficient length of time to free the alumina slag, which would give better results.

Rust on turnings had much to do with loss on melting. The ordinary melting loss on turnings which were quite clean would be about 2½ per cent., but he had experienced sometimes a loss of 20 per cent. where the turnings were more like iron ore than anything else.

MR. HOLMES (interposing) said he was interested in Mr. Paulin's remarks regarding the use of aluminium in cast-iron practice for the purpose of absorbing gases and getting clean machining surfaces. He (Mr. Holmes) thought that there was only one objection to the use of aluminium for that purpose, namely, that the rate at which steel or cast iron could be deoxidised by aluminium depended upon temperature, and metal melted in a cupola was very rarely hot enough to make it a commercial proposition. He did not altogether agree with what Mr. Stobie had said about alumina slagging off, as he did not see how this was possible. He considered the alumina would remain in suspension in the metal.

In reply to Mr. Holmes, MR. STOBIE said that if a certain amount of aluminium was added for the purpose of deoxidising steel, when the latter was analysed it would be found that the amount of aluminium was distinctly less than that which had been added, which fact tended to prove that alumina had slagged out.

He mentioned that during the war he had made for a certain firm a quantity of steel for torpedo air vessels. The steel had hitherto been made in an open-hearth furnace, and there had been much trouble due to slag inclusions, which proved to be manganese silicate, and it had been decided, therefore, to try making the steel in the electric furnace. Many microphotographs of the steel were taken, with the result that no slag inclusions whatsoever could be seen. As a final test, a forging, about 15 ft. long, was made. A very small cut was taken, in a lathe, off the whole length of the forging, and there was not an involuntary break in the whole length of turning, which there would have been had any slag been present.

A hearty vote of thanks was accorded to the lecturer.

Discussion on Mr. Edwards' Paper on "Runners and Risers."*

Dr. Desch, at the conclusion of Mr. Edwards' address, said there was no doubt it was a very practical one and one which he was sure appealed to many of those present. He then invited the members present to discuss the points which had arisen in their minds.

Major Rhydderech, in opening the discussion, said there was no doubt the Paper had been a very interesting one, and a large number of points had been raised of interest to every moulder, but more particularly he thought to the cast-iron moulder. On the subject of gates being constructed was to avoid the smashing up of the mould because of a big drop, he thought the subject was being overdone, because there was no reason for it if a fine oil-sand core were used, and it would not be necessary to have three or four separate drops. He agreed, however, that one or two might be useful. With regard to the example given in Fig. 7, it appeared to him that that figure was cast upside down. He believed that if that casting was turned the other way the trouble mentioned by Mr. Edwards would have been avoided altogether. With regard to the use of risers to take away scum, he was of the opinion that it took a very large riser to take away the scum which formed. He did not think skimming gates were very effective. With regard to Fig. 14, he was rather interested in what Mr. Edwards had to say, and it reminded him of the Leonard effect, that is the defect was not due to shrinkage but to trapped air. The reason why the dry sand at the top did not break down was simply due to the fact that there was rapid heating and they expanded so rapidly that they ruptured and were held by the clay bond. When running in from the bottom there was always a fine, thin channel going up in the middle—it was always fluid in the middle, and therefore the centre of the mould would always show a pipe and be full of segregate.

Mr. Edginton said he did not like the idea of ribbing the core on the barrel and using it as a runner, because obviously one got a dirty metal and that would not be for the good of the casting as it escaped out. In a previous lecture they had there they had had an interesting discussion on gates and risers and about gates being smaller than the down riser. Mr. Edwards had shown them gates with a bigger area than the riser, and he also spoke of throwing coal dust at the front of the gate to prevent scabbing. He (speaker) did not think the use of more coal dust would prevent scabbing. With regard to Fig. 6, he certainly thought it should be made the other way up, because he could imagine the trouble which would arise with the metal going in on that narrow neck at the bottom. He thought that would be asking for trouble to put a runner in where the narrow neck was. He agreed with the last speaker that risers would not take scum off, and neither did he see the use for blind risers.

Mr. J. Shaw said he, too, was in agreement with the previous speakers that risers were not of much use in taking away sullage. They cleaned local spots, but beyond that they were of no use. He was also fairly in agreement with the other speakers about the Fig. 7 being cast the other way up. There were times, of course, when the small bottle-neck was bound to be cast at the bottom and one had to make provision for it. He agreed with Mr. Edginton on the question of the cores. He saw no benefit to be derived by stepping. There were a number of other points in reference to which he was afraid Mr. Edwards would come off badly if they were discussed fully. With regard to the question Mr. Edginton had mentioned about the diameter on the end of the down runner, he thought that depended entirely on the type of runner used. Frankly, he did not see why one should be an inch and another an inch and a quarter. Gates and risers were very important things and had been realised to be such especially by repetition people, who have special designing departments for their patterns. They should, in fact, be on the patterns themselves for such work, say, as typewriter parts and other small work, and not left to the moulder, however experienced he might be. A man may be skilled enough, but in repetition work he might easily have variation. There should be special designs on the pattern.

Mr. Ollerenshaw expressed the opinion that too much coal dust was used sometimes in moulds. He thought it would be better to use less coal dust and make further use of coke dust. Coal dust created too much gas.

Mr. P. Green said it could not be definitely stated that the size of the in gate should be larger than the down gate, for whilst this was desirable for some castings it was disastrous for others.

Mr. W. H. Bowe thought there was some difference in the viewpoint of Mr. Edwards and the previous speakers. Some were talking from the angle of the steel moulder, and others were talking from the cast-iron point of view. The result was rather confusing. In one it was advisable to have the runner from the bottom and in the other from the top. There were times when risers were essential. With regard to the Fig. 7, it might have been for the sake of economy that it was done the way Mr. Edwards had indicated, especially if machining was to take place at the bottom where the collar was. He had been interested to hear of a blow being covered and regaining itself. He had never heard of such a thing before and it had greatly interested him.

Mr. W. Cowley also expressed the belief that Fig. 7 should be the other way round.

Mr. Hoyland said it appeared to him that in grey-sand castings blind risers were useful. In thin sections, if a whistler were used there was a tendency to blow through them. It was very handy to have a blind riser or whistler. With regard to the position and uses of gates, a round downright was preferable in steel, though they used skimming runners on a heavy job. Dr. Moldenke, he thought, advised top pouring to get castings which would machine up properly.

The Author's Reply.

Mr. Edwards, in the course of his reply, said he was glad to see that his Paper had evoked so much discussion, which he hoped would do good. What he had had to say was based chiefly on actual experience of works practice, and though some could not agree with him on some points, he could assure them the results were satisfactory. He noticed that opinion was fairly divided in reference to Fig. 7. What had been said for and against may be said to have cancelled each other. On the subject of breaking the joint, he would like to point out that with metal dropping down several feet there was the probability of little pieces of shot flying up and they would find them in the casting. The break of the joint depended on the drop. With reference to the remarks that in spinning gates there was a lot of waste metal, he could only say that in practice the method answered very well. In general he thought that each casting must be dealt with on its merits. Each had its own peculiarities which should be considered. The cases he had cited were those in actual practice. With reference to the chills on wheels, all he had to say was that the chills were placed on the bottom and they worked satisfactorily. A dry-sand top would fall in like green sand. On the subject of coal dust, he would like to point out that the moment it was brought into contact with molten metal combustion took place. This prevented the metal from eating into the sand. For light jobs or very thin work one did not want very much coal dust. There could not be one definite specification for all jobs. His experience of dummy risers was that they gave clean castings and were economical, and did not let the foundry profits go to the machine shop. With reference to the large gates, the advantage was when you had to get thin metal: there was an inner core of hot metal. The prodded ring gave the gas a better chance of escape than the bush. One reason why Fig. 7 was run from the bottom was because they wanted the metal at the bottom to be the best. He thought 12 hours for chilling some rolls was not out of the way.

On the proposal of Dr. Desch, a vote of thanks was passed to the lecturer.

* This Paper has appeared in our last two issues.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

American Arbitration Bar.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I was interested to read the A.F.A. statement sent to clarify their Committee's view-point respecting the above bar. Frankly, I fail to see what light has been thrown on the subject. I take it that the physical tests attached to C.I. specifications issued by either the Bureau of Standards or the B.E.S.A. are arrived at after several meetings between engineers, metallurgists and foundrymen. The tests imposed are such that the foundryman agrees can be attained by ordinary good metal of the right composition. The engineer accepts these figures as reasonable. He includes them in his specification when necessary, and also bases his calculations for the strength of any machine he designs, probably using a sixth of the breaking load as his margin of safety.

The primary object of the B.E.S.A. in including physical tests in their specification is not for shop control, *but to ensure that the engineer obtains the strength agreed upon*, so far at least as the quality of the metal is concerned.

We have never thought that a test-bar was the best means for obtaining this information, but so far no one has put forward a better scheme other than testing the casting itself. This is not often possible, and in cases where it is, much harm has been done by overstressing it. Hence the I.B.F. effort to bring the test-bar into line with our present knowledge of mass action and cooling effects. How vital that is was shown by Bolton's figures at the last A.F.A. Convention. He stated that with iron suitable for a 1-in. test-bar he obtained 40,000 lbs. per sq. in. tensile. From the same metal cast into a 2-in. bar he only obtained 25,000 lbs. per sq. in. tensile, or a drop of 38 per cent. Thus, in increasing the section from 1 to 2 in. thick the engineer's factor of safety drops from 6 times to between 3 to 4 times. If the sections varied more, greater discrepancies would be shown.

What is the exact meaning of the term arbitration bar? Does it not imply that in case of a dispute between buyer and seller regarding the suitability of the metal used, this bar is evidence either for or against that issue. Yet according to Bolton's figures, if the section of the casting was 3 in. thick, the factor of safety would be reduced to about one-half of the calculated figure, if the 1¼ bar formed the basis for that calculation.

Having now cleared the ground, let us examine the points raised in the A.F.A. reply, *seriatim*.

As a member of the A.F.A. of 13 years' standing, I was told that any criticism was in order, and welcome. I made no mention of any "International bar." At the same time, in view of the recent Pan American Conference, whose avowed object was to arrive at an agreement with the various nations of South America to adopt the Bureau of Standard specifications, it is evident that the 1.2-in. bar may become an "International bar." That without consultation with one of the chief exporting countries to these States, and probably to its detriment.

If we accept the A.F.A. dictum, that a test-bar is only indicative of the quality of the metal in the ladle, then that metal must be suitable to the work in hand if this calls for standard tests. The A.F.A. Committee states: "That one may want hard, medium and soft castings of about the same section thickness." Yet for these the A.F.A. specifies that a 1¼ bar tested at 12-in. centres must yield the same breaking load and deflection. In short, from the same ladle of iron the A.F.A. expects to obtain soft, medium and hard castings of the same sectional thickness. Of course, we understand that each of these castings has to comply with the A.F.A. specification, and would, if of medium section, give a minimum of 2,900 lbs. on the 1¼ bar. If not, why muddle the issue by naming work that is not affected by the specification? The A.F.A. also states that I give the impression that a certain thickness of casting should always contain metal of a given strength. I accept this if they all call for the same physical tests. It is certainly implied in the A.F.A.'s specification when they say, for instance, "That for castings in which no section is less than 2 in. thick, the 1.25 bar must not yield less than 3,300 lbs. when tested at 12-in. centres."

The Committee also gives as examples three types of electrical castings. Again, I take it each of these castings must comply with the A.F.A. standard tests. This I know is not the case with either resistance grids or generator frames, which are controlled chemically and by certain tests obtained from works experience. Again, I ask, why confuse the real issue by naming castings that do not use the standard arbitration bar and TESTS?

I fail to see that three sizes of bar will lead to more muddle than one size of bar having three different breaking loads. If we take the three types of castings just named, grids, turbine-generator frames. In the A.F.A. case they would have three 1.25 bars. The first required to give 2,500 lbs. minimum load, the turbine 2,900 lbs., the thick frame a load of 3,300 minimum. Any error in marking or neglect to mark would lead to confusion at once, as all the bars are the same size. In the case of the I.B.F. bars, not only is the increase of the section of the bar in relation to the increase of the section of the casting metallurgically correct, but the various sized bars lead to less liability of error. No one would use either a 1.2-in. or a 2.2-in. bar for the grids. The thin section demands at once the 0.875 dia. bar.

Coming now to the concluding paragraph, I think we on this side have proved that we desire closer co-operation with foundrymen everywhere. We value very highly the remembrance of the American visit in 1923. We appreciate to the full the goodwill and welcome shown to our members who have visited the States. We are looking forward to the great time we are going to have together in 1926. At the same time we would point out certain facts that are not helpful to that better understanding.

The A.F.A. Committee on Tests, of their own initiative, proposed to try out the I.B.F. specification, in conjunction with their own. That trial was a farce. In no case, except the Chairman's, was metal used suitable to the size of the bar cast. In every case, with that exception, was the 0.875-in., the 1.2-in., the 2.2-in. bars cast out of the same metal, suitable or otherwise. Instead of the trial giving useful information to both Committees, it was a pure waste of money.

Neither is it conducive to co-operation if reasonable criticism is suppressed as was the case over this arbitration bar question.

The American foundry Press refused publication because it was not thought to be in the best interests of the Association. The editor of a second journal, after accepting the article, wrote a week or so afterwards regretting he could not perform his promise. Contrast that with the attitude of the official organ here (THE FOUNDRY TRADE JOURNAL), whose columns are always open to genuine criticism from members of the A.F.A.—Yours, etc.,

J. SHAW.
Chairman I.B.F. Committee on Test-bars.

British Research Work.

Foreign Appreciation.

The ballot for the election of members of the Institute of Metals, taken on Monday, May 4, resulted in the addition of the names of 53 persons to the membership roll. Of these 31 are resident in Great Britain and 22 abroad. The high proportion of foreigners joining the Institute of Metals is striking. It is an indication of the desire on their part to secure, through the Institute's Journal, the latest scientific information regarding non-ferrous metallurgical research work. The recent election brings the Institute's total membership to 1,164, of which 387 members are resident outside the British Isles. A further ballot, particulars of which can be obtained from the Secretary, Mr. G. Shaw Scott, M.Sc., 36, Victoria Street, London, S.W.1, will be held on July 8, *i.e.*, at the beginning of a new financial year of the Institute. Members elected as a result of this ballot will be eligible to participate in the Glasgow Meeting of the Institute to be held from September 1-4.

Trade Talk.

Robert Stephenson & Company, Limited, of Darlington, have just obtained a contract from the L.N.E. Company for twenty tank locomotives.

Over 100 electric crane drivers at Harland & Wolff's shipbuilding yard have ceased work owing to the refusal of an increase in wages of 10s. per week.

The imports of ore at the Senhouse dock at Maryport in April only totalled 4,000 tons, against 11,100 tons for March, and 8,800 tons at the corresponding period of last year.

The North Lincolnshire Iron Company's works at Scunthorpe, which have been closed since September 22, are starting again, and two furnaces will be put into blast immediately.

A fire has occurred at the Dannemore Steel Works, Sheffield, caused by an accumulation of oily waste and dust in the ventilation shaft of the hacksaw department becoming ignited. The outbreak was speedily extinguished, and only slight damage was done.

Vickers, Limited, we understand, have disposed of their interests in Vickers and International Combustion Engineering, Limited. It is rumoured that an amalgamation is pending between the Underfeed Stoker Company, Limited, and the International Combustion concern, with a view to extending and further exploiting the Lopulco system of pulverised fuel.

Howden-Ljungstrom Preheaters (Land), Limited, have received an order to supply one preheater to S. Fielding & Company, Limited, Stoke-on-Trent. The total heating surface of the preheater is to be 5,100 sq. ft.; air will be supplied to the furnace at about 510 deg. F.

Vickers, Limited, have an order from the Salt Union, Limited, Winsford, Cheshire, for a sectional pontoon type of floating dock capable of lifting small vessels up to 300 tons displacement. The pumping installation consists of one centrifugal pump electrically driven, current being supplied from the shore for the pumping and lighting of the dock. The dock will be erected in an arm of the River Weaver near Winsford.

The Underfeed Stoker Company, Limited, have recently taken orders for 62 travelling grates, including the Mond Nickel Company, the Fife Coal Company, the Londonderry Collieries, Wm. Baird & Company, Limited, the Mickley Coal Company, and Baldwins, Limited; seven stokers, two air heaters, including Chatham Dockyard; four ash conveyors, including Chatham Dockyard and the Mond Nickel Company; two soda grates; a pulverised fuel plant for the Ashington Colliery; and eight suspended arches, including Wm. Baird & Company.

Extensions and additions have been made at the Stafford and Preston works of the English Electric Company, Limited, the cost of which is included in the increase of £152,000 in the value of land, buildings, plant, machinery, etc., now shown at £1,253,477 in the annual accounts. Arrangements having been made to liquidate the Coventry Ordnance Works, Limited, and to complete the liquidation of Dick, Kerr & Company, the Phœnix Dynamo Manufacturing Company, and the United Electric Car Company, the accounts for 1925 will take the form of a consolidated balance-sheet in which the asset "interest in subsidiary and other companies" will be adjusted accordingly.

The Great Western Railway Company have lately placed the undermentioned contracts:—Cables, switchgear and transformers for an electric distribution system at Barry Docks—English Electric Company, Limited; fourteen 30-cwt. hydraulic capstans for Cardiff, Swansea, Penarth and Barry Docks—Sir W. G. Armstrong, Whitworth & Company, Limited; overhead contact wires and trolley arms for four movable coal hoists at Queen Alexandra Dock, Cardiff—Brecknell, Munro & Rogers, Thrissell Street, Bristol; two electric luggage lifts, Hammond Bros. & Champness, Alfreton Street, Old Kent Road, S.E.1; electric luggage lift, Etchells, Congdon & Muir, Mill Street, Ancoats, Manchester.

The returns for April of Clyde shipbuilding show that a large volume of tonnage was launched on the river during the month. In all, 24 vessels of 94,046 tons were produced, the highest figure this year. This output compares with 27 vessels of 19,305 in the corresponding month of 1913, in which the "Aquitania" was launched at Clydebank, and with 34 vessels of 85,774 tons in April, 1919, now the third highest. For the four months of the year the total launched consisted of 76 vessels of 237,504 tons, as compared with 59 vessels of 139,906 tons in the corresponding period of last year, and 68 vessels of 237,161 tons in 1913, which was the record, now beaten to the extent of 8 vessels and 343 tons. Very few contracts were received during April of this year, however, and in the course of the next two months there will not be a single liner in the berths, so rapid has been the rate of construction.

Obituary.

Mr. H. Dyson, of Sheffield, a retired steel manufacturer, died recently, at the age of 74 years.

Mr. J. Fulton, general secretary of the National Union of Foundry Workers, died at his residence, 3, Khartoum Street, Old Trafford, Manchester, on May 6.

Mr. C. K. Etheridge, joint managing director of Etheridge, Dewar & Company, Limited, marine surveyors, engineers, etc., Seething House, 10, Byward Street, London, E.C.3, died recently, after a long illness, at the age of 70. The deceased gentleman spent the earlier years of his career at sea, subsequently becoming marine superintendent to Houlder Bros. On severing his connection with this company, he established himself in business as a consulting and contracting engineer. In February, 1923, the present business was established, the directorate comprising the late Mr. Etheridge and Mr. Norman M. Dewar (joint managing), Mr. Jas. M. Dewar and Colonel W. F. Cheesewright, D.S.O. The deceased gentleman became very well known and highly respected in the engineering and shipping circles of the Metropolis, and his kindly disposition and wonderful knowledge of all phases of the profession in which he was engaged will be sadly missed.

Gazette.

A petition for the winding-up of the Redheugh Iron and Steel Company, Limited, was heard in London on May 12.

The Gardiner Shipbuilding and Engineering Company, Limited, Lake Shipyard, Poole, Dorset, are paying a first dividend of 3d. in the £.

The examination in bankruptcy of Mr. E. C. Lewis, carrying on business at Batman's Hill Works, Bradley, near Coseley, under the style of the Midland Steel Tube Company, and E. C. Lewis and Company, has been concluded at the Dudley County Court. The statement of affairs showed a deficiency of £3,595. According to the observations of the Official Receiver, the debtor had been connected with the iron trade all his life. From 1914 he was acting as director of the Bradley Steel Strip Company, Limited, which company subsequently went into liquidation. In 1923 he commenced business as a merchant at Batman's Hill Works, trading as E. C. Lewis and Company. After about 12 months, debtor commenced the manufacture of tubes, trading as the Midland Steel Tube Company. In November, 1924, he executed a mortgage on the lease and fixed plant in favour of a creditor. Shortly after his supplies of steel were stopped, and he was unable to continue.

Company News.

White Machine Tool Company, Limited, Dunkirk Foundry, Dunkirk Street, Halifax.—Capital £2,000 in £1 shares. Directors: A. White and A. Crowther.

English Electric Company, Limited.—Net profit, £263,781; brought forward, £69,713; total, £333,494; written off expenses of debenture issue, £9,007; dividend, 5 per cent., less tax, on ordinary shares; carried forward, £73,917.

Guest, Keen & Piggotts, Ltd.—Capital £40,000 in £1 shares, to adopt an agreement dated January 29, 1925, between Guest Keen & Nettlefolds, Limited, and Thomas Piggott & Company, Limited, and to carry on the business of manufacturers and factors of and dealers in mains, pipes, conduits, poles, wires, etc. Directors: W. R. Lysaght, W. Simons, T. P. Barker and A. Dyson.

Richardsons, Westgarth & Company, Limited.—Mr. T. Westgarth, presiding at Hartlepool, last week, at the annual meeting of this company, referred to the Diesel engines built by the firm, and, mentioning that a start had been made on the new type of experimental engine, said every effort would be made to arrive at the commercial stage of manufacture as early as possible. Regarding Government schemes for improved factory conditions, etc., Mr. Westgarth said, whilst these had their fullest sympathy, the country was at present unable to afford them. Pointing to a huge increase in rates, property tax, workmen's compensation, and national insurance, he said their company alone had in these charges paid £10,000 more last year than in 1913, and this entirely exclusive of income-tax. Touching on labour topics, Mr. Westgarth urged the necessity of the modification of harassing trade union restrictions, and expressed the wish that a great body of experienced workmen would attend their lodge meetings so as to counteract the more hot-headed members. He also spoke of the dissatisfaction among the engineering and other productive workers at the comparatively high wages in the sheltered trades.

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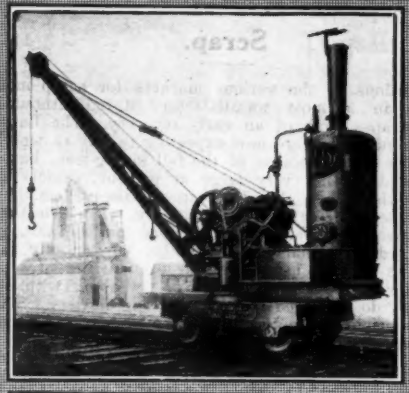

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IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—Although strictly confined within comparatively limited volume, business in the Cleveland iron markets of late has maintained a fairly steady tone, outputs at furnaces now being restricted on the whole to averages equal to consumers' immediate requirements, thus avoiding accumulations of stock at works. A few forward contracts have also been arranged. The export trade shows but little change, though the feeling here is, perhaps, a little more confident. At this week's market values were somewhat irregular, though within a narrow compass. Generally, 76s. 6d. per ton was adhered to for No. 3 G.M.B. for export, but truck iron could be done from 6d. to 1s. per ton below this figure. There was renewed interest in No. 1, and sales were effected at 82s. per ton. No. 4 foundry was round about 75s. 6d. per ton, and No. 4 forge 74s. 6d. per ton.

In the Tees-side market further weakness has developed in hematite values, which may probably explain the slight improvement now reported. The home demand, however, shows but little change, though there is a better inquiry from abroad, and a certain amount of forward business has been fixed up. East Coast mixed numbers are now quoted at 81s. per ton, and No. 1 at 81s. 6d. per ton. On the West Coast area conditions are about similar to those last reported, Bessemer mixed numbers being quoted at 87s. 6d. c.i.f. Welsh ports, 92s. per ton delivered at Glasgow, 97s. 6d. per ton delivered at Sheffield, and 100s. per ton delivered at Birmingham.

LANCASHIRE.—Buying on foundry account in this district is still on a restricted scale, consumers still retaining the impression that prices will soon reach lower levels. Of course, the fact that Northamptonshire foundry iron is offered freely at 70s. per ton at the furnaces, induces the local buyer of foundry iron to be sceptical when some Derbyshire makers say that 77s. 6d. is the minimum price. Up to date the lowest price admitted by sellers of Derbyshire has been 83s. 6d. per ton, although 82s. 6d. has been rumoured.

THE MIDLANDS.—So far as these particular markets are concerned, there has been no further reduction in the price of foundry pig-iron, the ironfounders, especially those engaged on heavy work, not finding business very brisk, and meet keen competition for any orders there are about. Current quotations rule as follow:—Derbyshire No. 3 foundry, 75s. to 76s.; Staffordshire No. 3 foundry, 76s.; Northants No. 3 foundry, 70s.

SCOTLAND.—Owing to the general slackness now prevailing in the various consuming industries of the North, the volume of business passing in Scotch pig-iron continues disappointingly small, and in most cases is still confined to prompt parcels. Consequently prices continue to ease, and No. 3 Scotch is nominally 86s. 6d. at the furnaces, and even this figure could no doubt be improved upon for a parcel.

Finished Iron.

Throughout South Staffordshire and adjacent districts ironmasters report only an indifferent demand for most descriptions of finished material, and mills are in many cases short of specifications. Of course, the chief difficulty is the very low price of Continental iron. At present this iron is being sold in this area as low as £7 2s. 6d. delivered, and from this can be estimated how impossible it is for the local works to get even a good proportion of the limited business available. Marked bars are quoted at £15 f.o.t. makers' works, and no difficulty is experienced in obtaining this price; but fresh orders for this grade lack tonnage, and the makers of this class of iron are not without anxiety for the time being, as their contracts are working out and the immediate future for further orders is not too promising.

Steel.

Recent developments in the steel market indicate some improvement in the buying of acid billets, but basic qualities remain in poor demand It may be explained that the prices of billets have not been decontrolled under the announcement that the Associated steel makers have withdrawn their official minimum prices. Soft basic billets have, of course, been decontrolled for some time, but control of hard basic and acid billets continues in operation. Bessemer acid billets are still £12 and Siemens acid £11 10s. per ton. Basic prices are:—Soft, £8 to £8 10s.; medium, £8 15s. to £9; hard, £9 5s. to £9 10s. The output of the basic open-hearth furnaces in the Sheffield district is still falling, but acid steel is rather better. The rod mills are running short time, but a new sheet mill has just been opened. The abandonment of the recent scheme for the control of tinplate prices has demoralised the market for a time, and prices have consequently declined, current quotations ruling 21s. and under per standard box, delivered, f.o.b., Bristol Channel ports.

Scrap.

Conditions in the various markets for scrap metal remain in a most unsatisfactory state, without at present any signs of an early recovery. The Lancashire ironfounders are now expecting to buy cast scrap on easier terms because of the fall in pig-iron, but as the supply is not very large at present, dealers are doing what they can to keep up the prices. For special scrap from textile machinery, of which there is a scarcity, dealers quote 85s. per ton, and 80s. for good ordinary machinery quality, but in any case foundries are not using very large quantities of scrap just now, and many of them can get along with odd lots and do not need to go to the big dealers. Similar conditions are noted in the Scotch markets, where machinery cast-iron scrap can easily be obtained around 85s. to 86s. 3d. per ton, and for ordinary quality 5s. per ton less. Steelworks cast-iron scrap in furnace sizes is more sought after around 75s. per ton. Cast-iron railway chairs can also be had at 82s. 6d. to 85s. per ton. Light cast-iron scrap and firebars are in poor demand, and sellers have difficulty in obtaining even 67s. 6d. per ton. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—During the past week the position of standard copper has experienced a relapse, the result of sustained selling pressure on the part of the bear element in the market and the adverse effect of a disclosure of the stock situation. This embodies the fact that the total stock of blister and refined are close on 400,000 tons, and at the time of writing this has done much to upset sentiment. It has also been argued, with results satisfactory to the bear element, that the estimates of the world copper production are larger than demand by at least 10 per cent.; hence the renewed weakness which has set in. Current quotations:—*Cash*: Thursday, £59 17s. 6d.; Friday, £60 5s.; Monday, £60 10s.; Tuesday, £60 5s.; Wednesday, £60 5s.

Three Months: Thursday, £60 17s. 6d.; Friday, £61 2s. 6d.; Monday, £61 10s.; Tuesday, £61 2s. 6d.; Wednesday, £61 5s.

Tin.—Contrary to the experience of the copper section, there had been a sharp recovery in tin about the middle of April, and since then a sustained and steady advance has been witnessed, carrying values by the end of the month to high levels. A reaction subsequently took place, causing a decline of nearly £5 a ton under general profit taking and bear selling. Certain interests in the market are still using depressing tactics on every possible occasion, thereby causing general unsettlement. Current quotations:—*Cash*: Thursday, £240 2s. 6d.; Friday, £239 12s. 6d.; Monday, £243 15s.; Tuesday, £242 15s.; Wednesday, £243 5s.

Three Months: Thursday, £242 5s.; Friday, £242; Monday, £245 15s.; Tuesday, £244 15s.; Wednesday, £245 5s.

Spelter.—Following a brief spell of lower values, the market for this metal developed a stronger tendency, with April delivery quoted £35 10s. Later, however, values have given way under weak American advices and lack of buying for consumption. No doubt there still remain many orders to be placed by consumers during the next few months, but the production of zinc goes on apace, and, with the demand from Germany not so good as it was, the supplies should be more than ample to meet all requirements. Current quotations:—*Ordinary*: Thursday, £34 2s. 6d.; Friday, £34 2s. 6d.; Monday, £34 5s.; Tuesday, £34 7s. 6d.; Wednesday, £34 5s.

Lead.—The market for soft foreign pig has recently indicated some irregularity, and at one time prices fell below £31, but from this point a good rally started and the tone became firmer, with a substantial gain. Really the recovery followed heavy buying by consumers, which frightened bears into covering rapidly. The recovery was much too fast, and so soon as consumers withdrew, bears resumed their operations and, prices once more are falling. Current quotations:—*Soft foreign (prompt)*: Thursday, £31 17s. 6d.; Friday, £32 5s.; Monday, £32 12s. 6d.; Tuesday, £32 13s. 9d.; Wednesday, £32 3s. 9d.